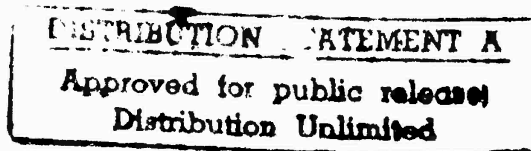DTIC
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The Changing Balance

South and North Korean Capabilities for Long-Term Military Competition

Charles Wolf, Jr., Donald P. Henry, K. C. Yeh,
James H. Hayes, John Schank, Richard L. Sneider

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This report has two principal purposes: to analyze South Korea's economic, technological, and political-social capabilities for long-term competition with North Korea, and to evaluate the relative capabilities of the two sides. Using a variety of methods and approaches, including formal quantitative models and qualitative essays, the authors reach the following primary conclusions: (1) South Korea has substantial economic and technological advantages over North Korea; (2) the South's economic preponderance over the North is growing rapidly; (3) South Korea's economic and technological development give it advantages in its long-term military competition with the North; (4) South Korea can increase its military self-reliance; (5) South Korea's advantages over North Korea should increase substantially in the next decade; and (6) South Korea apparently provides a larger volume of resources for defense purposes, yet has a smaller military capability than does the North.

R-3305/1-NA

The Changing Balance

South and North Korean Capabilities for Long-Term Military Competition

Charles Wolf, Jr., Donald P. Henry, K. C. Yeh,
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December 1985

Prepared for the
Director of Net Assessment,
Office of the Secretary of Defense

PREFACE

The Korea Institute for Defense Analyses (KIDA) and The Rand Corporation have been engaged since 1983 in a collaborative analysis of the Republic of Korea's economic and technological capabilities to conduct its long-term military competition with North Korea over the next decade. This project is a sequel to Rand's earlier work with KIDA on the sustainability of North Korea's defense buildup. The present report focuses on South Korea, and combines new results with an updating of the prior work on North Korea. The aim is to assess the relative competitive strength of the two sides, and how this balance is likely to be affected by the passage of time. The report, which summarize the Rand work and its principal conclusions, will be supplemented by other Rand publications resulting from the project. KIDA's own work and conclusions are being reported separately.

Rand's participation in this analysis is supported by the Director of Net Assessment in the Office of the Secretary of Defense. KIDA's participation is supported by the Korean Ministry of National Defense.

The study should be of interest and use to U.S. and Korean decisionmakers concerned with defense policy and foreign policy in the two Koreas.

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SUMMARY

This report has two principal purposes: to analyze South Korea's economic, technological, and political-social capabilities for long-term competition with North Korea; and to evaluate the relative capabilities of the two sides by combining our current analysis of South Korea with a previous Rand study of North Korea. Both the previous and the present studies have been made in collaboration with the Korea Institute for Defense Analyses. Considered together, the two studies try to answer the question, "On whose side is time?"

Primary conclusions are that:

1. *South Korea's economic and technological advantages over North Korea are substantial.*

The economy of South Korea is currently about four-and-a-half times as large as that of the North. Consequently, military spending in the South of between 6 and 7 percent of GNP is equivalent in real terms to between 27 and 31 percent of North Korea's GNP—a share that is probably somewhat above what North Korea actually devotes to direct military uses. A similar technological gap is found between the two sides.

2. *The South's economic preponderance over the North is growing rapidly.*

South Korea's annual rate of real economic growth is currently between 7 and 8 percent, compared with our estimates of 2.5 to 3.0 percent for North Korea. The economic simulations described in this report forecast a slightly declining rate of growth for South Korea in the next decade, generally varying between 5 and 6 percent per annum for the principal scenarios formulated. Nevertheless, this growth rate would still be more than twice that of our forecasts for North Korea. On this basis, the South Korean economy will be more than six times as large as that of the North by the mid-1990s. Hence, military spending of 6 to 7 percent of South Korea's GNP would then be equivalent to defense spending in the North of between 36 and 42 percent of its GNP.

3. *South Korea's economic and technological development affords major opportunities for it to realize significant advantages in its long-term military competition with the North.*

Some of these opportunities lie in drawing more fully on the civil economy to augment South Korea's military capabilities. Examples include enhancing its general industrial mobilization capabilities in the event of a crisis; augmenting its order of battle through contingency

plans to use vehicles, airlift, shipping, maintenance facilities, and engineering and construction capabilities from the civil economy; and achieving peacetime cost savings through deregulating the defense industry and through greater use of subcontracting in the civilian economy to support appropriate military functions.

Other advantages for the long-term military competition would require a direct diversion of resources from the South's civil economy to increase its military capabilities. For example, enhancement of South Korean amphibious and airborne forces to create a credible counteroffensive capability would be a move in this direction. North Korea has been in the fortunate position of being able to deploy most of its forces for attack. By contrast, South Korean forces have been configured and deployed for defense, leaving North Korean territory above the DMZ relatively unthreatened by a combat-ready South Korean force capable of occupying it. A decision by the South to move in this direction would of course require careful consideration. On the one hand, such an enhancement of South Korea's military capabilities could add to deterrence and stability by obliging North Korea to retain some of its forces for protecting Pyongyang, thereby diminishing the North's concentrated threat at the 38th parallel. On the other hand, such a move could be provocative and, for example, might trigger stepped-up support for the North by the Soviet Union to provide a countervailing expansion of North Korean forces.

Expansion of South Korea's military capabilities along these lines would involve a rise in defense spending of from 2 to 3 percent of its GNP during the next decade. In principle, such an increase is well within the economic and technological capabilities of the Republic. For example, this increased military burden could be offset in whole or in part by the efficiency gains for the South Korean economy that would result from reduction or elimination of agricultural subsidies. Nevertheless, defense spending of 8 or 9 percent of South Korean GNP would represent a significant additional stress on the country's polity and society.

In sum, the constraints on South Korea, in seeking to strengthen its military capabilities by drawing substantially more resources from the civil economy, are mainly political, whereas those faced by North Korea in attempting to enhance its military position are predominantly economic and technological.

4. *A corollary of the foregoing points is that South Korea can plausibly aspire to an increasing degree of military self-reliance.*

For example, U.S. ground forces in Korea derive their principal value as a symbol rather than as a combat force. The direct military contributions of these forces could be provided from an enhancement

of South Korea's own corresponding ground force capabilities, along lines described in our report, with responsibility for advanced weapons protected by a modest expansion of U.S. tactical air forces. However, as in the case of U.S. forces in West Germany, the symbolic importance of a major U.S. presence can hardly be overestimated. Nevertheless, if the United States and the Republic of Korea were disposed to do so, there is no inherent reason why the two allies could not maintain or even increase that symbol at a lower level of U.S. ground forces in Korea—perhaps by expansion of U.S. air units and a firmer reiteration of U.S. declaratory policy. That such measures would have to be developed carefully, deftly, jointly, and cooperatively is both obvious and crucial.

The role of foreign military sales (FMS) in supporting Korea's force improvements along the alternative lines described in the report, as well as their role in contributing to increased military self reliance by the South, may be more important than is suggested by the fairly small effect that FMS has on the simulation results summarized in the study. The limited effect of FMS in our simulations is, at least in part, a by-product of the high level of aggregation reflected in our small model of the Korean economy (SMOKE).

5. *The question posed at the outset—"on whose side is time?"—can be answered directly: South Korea's economic, technological, and military capabilities can be expected to grow substantially relative to those of North Korea during the next decade. The resulting balance should increasingly and predominantly favor the South.*

This conclusion leaves unanswered the question of how the changing balance in South Korea's increasing favor will affect the behavior of the North. On the one hand, it may lead the North toward more conciliatory behavior, and there have been some modest signs in this direction over the past year. On the other hand, it is not less likely that the anticipated change in the balance could lead North Korea toward more aggressive efforts to interdict the growing disparity between the two sides. This, in turn, may be affected by restraint or prodding from the Soviet Union or China—more likely restraint by the PRC than by the Soviet Union.

Moreover, our general conclusion is subject to important political constraints and uncertainties that are elaborated in the report, especially those relating to the constitutionally provided transfer of executive leadership in South Korea in 1988. Further uncertainties arise from various economic factors that we have treated as exogenous variables. It is worth noting that these factors may well be more important than the choice among alternative South Korean force postures and their corresponding military spending levels that are discussed in

this report. The exogenous factors include possible changes in South Korea's terms or volume of trade (with respect to oil prices, or changes in the degree of protectionism in international markets for Korea's exports), labor supply, and aggregate productivity. Yet these factors are as likely to move in directions contributing to South Korea's economic strength as ones that would impede it. The importance of these factors is suggested by our estimate that favorable or unfavorable combinations among these exogenous variables can substantially alter the expected growth of the Korean economy: for example, if the exogenous factors develop in congenial directions, South Korean annual growth could be above 8 percent, whereas if they combine in adverse ways, its annual growth might be as low as 3 percent.

6. *Our preliminary comparisons between relative military spending in South and North Korea suggest an interesting paradox: South Korea apparently provides a larger volume of resources for defense purposes, yet has a smaller military capability than does the North.*

In the period from 1976 to 1983, South Korea's cumulative military expenditures were about 25 percent greater than those of the North. Yet South Korea's total armed forces are slightly smaller than those of the North, and its military capital stock is also smaller than the North's. Two comments on these observations should be made immediately. First, judgments about resource allocations in the North—military spending, GNP, growth rates, and so on—should be treated with ample reservations because of inadequacies in both the quantity and quality of the data on which they are based. Second, the spending *vs.* capabilities paradox is very substantially, but not wholly, accounted for by higher costs of military manpower in the South.

Disaggregating the two sides' total military expenditures into their component parts gives a better picture of the paradox. From 1976 to 1983, the South has spent between two-and-a-half and four times as much on personnel costs as has the North; until 1982, this difference explained nearly all of the spending paradox. During this period, the North spent considerably more on operations and maintenance than did the South, presumably reflecting its larger military capital stock, and a higher utilization of military capital in more active patrols and more frequent military exercises. On the other hand, since 1976, the South has been spending more than twice as much on procurement as the North: projections based on the two sides' relative rates of growth in military investment suggest that, within the next few years, the total military capital stock of the South will exceed that of the North.

Our preliminary analysis only scratches the surface of the paradox, raising issues that warrant more thorough investigation. Apart from the obvious importance of refining these estimates of the two sides'

military expenditures, the key question is whether the apparently larger expenditures by the South signify relatively greater current or impending military effectiveness for the South than has usually been allowed for. Clearly, effectiveness depends on such qualitative factors as morale, leadership, education, and training, and these are not evident from our comparisons of military spending. Here again, the balance sheet is inconclusive. On the one hand, higher personnel costs in the South should reflect the higher quality of South Korean military personnel. On the other hand, the more intense indoctrination, austerity, and regimentation of military personnel in the North may produce manpower with an intensified capability and proclivity for effective combat.

In sum, our preliminary exploration of the paradox suggests the following conclusion: as the economic and technological base of the South continues to expand at the pace we have forecast, and as the substantial gap between the two sides widens still further, South Korea's capabilities for the long-term military competition seem likely to dominate those of the North. The paradox that has been manifest in the past will then be plainly resolved in favor of the South.

*   *   *

The foregoing conclusions are based on a variety of methods and approaches, varying from formal quantitative models to qualitative essays. Section II presents a systematic inventory of the political and social dimensions of the comparison between South and North Korea, focusing on the strengths and vulnerabilities of the two countries. On balance, we conclude that both South and North Korea are stable societies, capable of sustaining their current, or even increased, military burdens. However, both North and South face important political uncertainties: in the South, because of the unprecedented transfer of presidential power impending in 1988; in the North, because of the also unprecedented impending shift of political leadership from Kim Il-Sung to his son, Kim Chong-Il.

Section III summarizes an aggregative econometric model of the South Korean economy, which we have developed to test the effect on that economy of alternative South Korean military force postures and spending levels, as well as other exogenous circumstances such as shifts in South Korea's terms of trade.

Section IV outlines three alternative force postures which we have developed to indicate broadly different directions in which South Korea's force modernization may proceed, with varying economic burdens associated with each option. Option I, the base case, represents

the current force plus the planned force improvement program, a total of 23 army divisions and a manpower level (all three services) of about 630,000 men. Option II represents an expanded force posture, which would augment existing forces by adding a credible counteroffensive capability, with a manpower complement 24 percent above that of Option I. Option III represents an advanced technology force, trading off higher technology weapons and equipment against a reduction of 30 percent in active military manpower. Total incremental 10-year system costs (in 1982 dollars) of Option I (above the costs of Korea's forces in 1983) are estimated as $18.3 billion of investment costs and $1.8 billion of annual recurring costs; those of Option II are $29.1 billion of investment costs and $3.3 billion of annual recurring costs; and those for Option III are $25.0 billion and $1.0 billion, respectively.

The effects of these alternative force postures on the Korean economy are evaluated in Sec. V by applying the corresponding cost estimates as inputs to SMOKE to determine the responses of Korean economic growth, civil consumption, and the share of military spending in GNP over the 1984–1994 period. The three military alternatives have only slight effects on GNP growth rates, which do not vary by more than 0.2 percent between the highest and the lowest growth options (Options I and II, respectively). The corresponding effects on civil consumption growth are somewhat greater: the higher cost option (II) lowers civil consumption growth by amounts that vary from 0.3 to 0.5 percent per year over the 1984–1994 period. Consumption growth associated with Option II is between 4.5 and 4.7 percent per year, whereas the two lower cost options (I and III) yield approximately equivalent rates of growth in civil consumption, about 5.0 percent per year. The largest differences among the options relate to their respective defense burdens, construed as the ratio between military spending and the South Korean GNP. Military spending under Options I and III varies between 7.5 and 8.4 percent of the Korean GNP during the 10-year period, while Option II, the counteroffensive option, results in a defense share of GNP about two percentage points above the shares associated with Options I and III.

Our simulations also investigate the extent to which other circumstances besides the three military force posture choices may affect the performance of the South Korean economy. We explore the effects of technological progress, growth of South Korea's labor supply, changes in oil prices, possible shifts in South Korea's terms of trade, and capital inflows and foreign military credits. The effects of changes in the first three of these factors—technological progress, labor supply, and terms of trade—are likely to be greater than the effect of any of the alternative military options mentioned earlier. Furthermore, com-

bining these exogenous circumstances into "best-case" and "worst case" scenarios has a much greater effect on the performance of the Korean economy than the alternative assumptions about defense postures and military spending levels referred to earlier.

Section V also summarizes our updating of previous simulations of the North Korean economy. This updating has included a reestimate of North Korean military manpower costs to raise them about fifteen-fold over what they were previously. These estimates have been used in turn to revise our previous forecasts of North Korean economic growth and military spending, and to extend these forecasts into the mid-1990s for comparison with the South Korean forecasts. Furthermore, all of the new estimates for North Korea have been expressed in 1984 dollars, to make them comparable with our estimates for South Korea. The resulting estimates for North Korea show rates of GNP growth for the 1982-1994 period of between 2.3 and 3 percent per annum, rates of growth in aggregate consumption between 2 and 3 percent per annum, and an average share of military spending in North Korean GNP that varies between 13 and 32 percent, depending on the scenario assumptions.

In Sec. VI, we address several important issues that have not been incorporated in the econometric model. These "off-model" issues relate to civil support from the South Korean economy for the long-term military competition, the paradox of relative military spending in North and South Korea, and the problem of agricultural subsidies in South Korea. The results of these separate analyses are contained in the numbered conclusions covered earlier in this summary.

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I. INTRODUCTION: OBJECTIVES, BACKGROUND, AND METHOD

A. PURPOSE

This report summarizes a collaborative study undertaken by Rand and the Korea Institute for Defense Analyses for two principal purposes: first, to analyze South Korea's economic, technological, and political-social capabilities for long-term competition with North Korea, and second, to evaluate the relative capabilities of the two sides for this competition over the next decade. In pursuing the second purpose, we combine our current analysis of South Korea with previous KIDA-Rand work on North Korea. We address also the questions: On whose side is time? To what degree? Several policy implications are drawn from the analysis.

B. METHODOLOGY AND LIMITATIONS

Our objectives are ambitious, and the methodology and data available for reaching them are contributory, rather than sufficient. For some aspects, we have developed quantitative models to guide the analysis—the small model of the Korean economy (SMOKE) developed for the present study by Rand, the input-output linear programming model for South Korea developed by KIDA, and the several models developed by both KIDA and Rand in our prior study of the North Korean economy. The models enable us to trace the economic effects of alternative military force postures and the effects of the economy's performance on resource availabilities and constraints confronting South Korea in its long-term competition with the North. We thereby obtain a basis for assessing the relative economic capabilities of the South and North to sustain and modernize their respective military forces.

Even for these more quantifiable aspects of the problem, however, there are serious asymmetries between the South and the North. Although the methods and models used in the previous work on North Korea are similar to those developed for South Korea, the data available for the South are overwhelmingly better than for the North. Hence, reliability of the results on North Korea is more seriously open to question than that of South Korea. Winston Churchill's characterization of the Soviet Union—"a mystery surrounding an enigma inside a

puzzle"—applies even more emphatically to North Korea than to the Soviet Union. Nevertheless, a recent review of some of our earlier forecasts of North Korean military spending in the 1980s provides some reassurance on their validity.

For other aspects of the study, less formal methods are employed. For example, to address certain potentially important issues involving the economy and the military sector, we are obliged to proceed outside the structure of our existing models. These "off-model" issues include potential benefits that the South Korean military may be able to realize from the dramatic growth of the civil economy and the rapid development of its technology; the paradox involved in comparing real rates of military spending in the North and the South; and, somewhat farther afield, the possibility of modifying agricultural subsidies in South Korea so as to ease the fiscal and general resource constraints facing South Korea's military effort.

The political and social analysis of South Korea's strengths and vulnerabilities, as well as those of the North, are even more distant from formal modelling and quantitative estimation. Indeed, while these comparative assessments are important for the study as a whole, quite different analytic methods and information must inevitably be used in making them. Our approach is to use an explicit set of categories for organizing and comparing the two sides' political and social strengths and vulnerabilities, as a means of arriving at judgments about this dimension of the South-North balance.

II. POLITICAL AND SOCIAL DIMENSIONS

To aid the comparison and evaluation of the relative political and social capabilities of South and North Korea for their long-term military competition, this section summarizes a separate report prepared by former U.S. Ambassador to Korea Richard L. Sneider as an input to the br der study.[1] This report provides a systematic inventory of the political and social strengths and vulnerabilities—the sources of stability and instability—in South and North Korea and thereby helps us arrive at qualified judgments of their respective capabilities. We also try to identify certain critical unanswered questions. Unfortunately, but unsurprisingly, unanswered questions on the effects of a widening economic and potential military gap between the two sides are likely to be of central importance in trying to develop preferred South Korean and U.S. policies over the next decade. By formulating the questions more sharply, we can at least help to identify key points where policy judgments need to be made.

1. *Elements of strength and vulnerability in South Korea.*

Although the South Korean government is authoritarian, it exemplifies "soft" authoritarianism, in contrast to the harsh totalitarianism of the North. Under the leadership of President Chun Doo-Hwan, South Korea has allowed wider scope for expression of opposition views. Also, diminished government control over the economy has provided increasing opportunity for the market mechanism to operate freely and effectively. South Korea's economic growth over the past two decades has been among the most impressive of any country in the world.

South Korea's social and political strengths rest on several prominent factors:

- The unifying bond exercised by the visible threat posed by North Korean forces and declaratory policy.
- The demonstrated record of South Korea's governmental effectiveness in contributing to the country's economic, diplomatic, and military accomplishments, as well as its proven capacity to manage the political and economic challenges of prior years, especially in 1979-1980.

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[1]Richard L. Sneider, *The Political and Social Capabilities of North and South Korea for the Long-Term Military Competition*, The Rand Corporation, R-3271-NA, January 1985.

- A broad public acceptance of the need for social discipline and the maintenance of law and order, which is intensified by an awareness that internal destabilizing actions might provide an incentive for North Korean intervention.
- The confidence and encouragement provided by strong political and military support from the United States, and by favorable access to U.S. commercial and capital markets.
- The increased international recognition and stature acquired by Korea, as reflected in the choice of Seoul as the site for the 1988 Olympic Games.

Yet the Republic of Korea also faces several sources of potential vulnerability:

- A lack of established political institutions and proven procedures for a nonviolent transfer of political power, which the Korean constitution requires in 1988.
- Signs of restiveness among parts of the Korean middle class as a reaction against restrictions imposed by even "soft" authoritarianism, and the unmet need for more flexibility in the Korean political system to adjust to these currents of change.
- Vulnerability of Korea's export-led economy to external factors outside its control (such as the oil-shocks of 1973–1974 and 1979–1980, and the development of protectionism in Korea's major export markets).

As the foregoing lists suggest, Korea's prospects for stability or instability are affected by external as well as internal factors, and by economic as well as strictly political and social ones.

On balance, our analysis concludes that South Korea is a stable society and that the Korean public is, by and large, prepared to accept sacrifices, forgoing greater material rewards to meet the necessary costs of defense. Current levels of defense expenditure are acceptable, especially since economic growth permits increasing resource availabilities for nondefense purposes, as well. Higher levels of defense spending would probably also be acceptable, especially in light of the North Korean proclivity to highlight the danger and immediacy of its threat, as exemplified by the Rangoon assassinations of 1983. A higher share of military spending in Korean GNP than the recent pattern of 6 percent would probably also be politically and socially tolerable. However, internal problems might arise if a higher defense share were to lead to curtailment of real absolute increases in civil consumption and investment. In addition, the increased foreign exchange cost that might be associated with larger military budgets could be a significant problem if it added to Korea's debt burden.

2. *Elements of strength and vulnerability in North Korea.*

North Korea's record of growing military power over the last 10 to 15 years is, in its own way, as formidable as South Korea's record of economic accomplishment. Underlying and reflecting this growth are several factors that represent sources of political and social strength and continuity in the North:

- Totalitarian control by a political and military leadership able to dictate and execute policy and to determine resource allocations without organized opposition.
- The high level of cultural, social, and political discipline that both facilitates and is enforced by totalitarian control.
- Isolation of North Korea from external influence and information, notably information about higher consumption standards, economic growth, and technological progress South of the 38th parallel.
- The ostensible threat from the South, which is magnified and exploited as a means of intensifying public mobilization, vigilance, and cohesion.
- Finally, a modest degree of support from both the Soviet Union and China, which the North Korean leadership seeks to manipulate to its advantage.

Although there are no credible threats to the political and social stability of the North under current circumstances, several potential sources of vulnerability exist in the longer run:

- The difficulties associated with the pending transfer of power from Kim Il-Sung to his son, Kim Chong-Il. (Kim Il-Sung's dominance of the North Korean leadership has been so complete that this transfer inevitably entails uncertainty and potential instability for the system as a whole.)
- North Korea's slow economic growth in recent years, together with its restricted access to modern technology.
- The limited support which North Korea has received from China and the Soviet Union.[2] (In addition, North Korea's policy differences with both China and the Soviet Union constitute recurring restraints on its freedom of action).

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[2]The support North Korea receives from the Soviet Union and China is a source both of strength and vulnerability: strength, in adding to the tangible and intangible resources available to the North; vulnerability, because the amount of support has not been lavish, and because the support itself provides a tether restricting the North's freedom of action.

- North Korea's diminished international stature due in part to the Rangoon incident and in part to the sharply contrasting achievements and stature of South Korea. (Although this gap is a further source of weakness for the North, its impact is blunted by the North's isolation from external information.)

This balance of strengths and vulnerabilities still allows the North to generate extraordinarily high levels of defense expenditures—perhaps the highest relative levels in the world. Moreover, it is not implausible that North Korea can provide levels of defense spending even higher than the roughly 20 percent share of GNP already directed toward its military effort, without thereby straining the existing order. However, at some upper bound, which is probably not far from its present military burden, the North may well confront limitations from the effects of reduced living standards and consumption levels on labor productivity, and on the diminished ability of the system to maintain positive rates of real economic growth.

North Korea's political problems of realizing a stable transfer of power may thus be seriously complicated by its economic difficulties, and by its needs for external capital and technology. In these circumstances, the North may—and yet, may not—consider revising its policies in the direction of a lessening of tension in its relationships with the South. Its softer line at present may be a step in this direction, although it is too soon to be confident of this judgment.

3. *Unanswered questions.*

There is no single metric, or unambiguous bottom line, for assessing the relative political-social capabilities of North and South Korea for the long-term competition between them. Both sides benefit from fundamental sources of strength and stability. Yet both also exhibit potential sources of stress and vulnerability, especially in the challenges they face in the transfer of political power from the established authorities to their successors: in the case of the North, from Kim Il-Sung to Kim Chung-Il, and in the South from Chun Doo Hwan to a constitutional successor in 1988. The constraints faced by the North in trying to direct still larger resources to military purposes are likely to be economic and technical in nature,[3] whereas the corresponding constraints in the South are likely to be political in character. Both sides are also subject to unpredictable shifts in the relationships among the larger regional powers: China, the Soviet Union, Japan, and the United States.

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[1]See Sec. V.

III. ECONOMIC MODELS OF SOUTH
AND NORTH KOREA

A. MODELS OF THE TWO KOREAS

One element in the long-term competition between South and North Korea is their relative rates of real economic growth. To make this comparison, and to evaluate the effects of both military and nonmilitary influences on these growth rates, KIDA and Rand have constructed five models. Two models dealing with North Korea were developed in an earlier collaboration between KIDA and Rand. The first model was based on input-output and linear programming (I-O/LP) techniques. It was designed to identify bottlenecks that might constrain North Korean economic and military development. The second model was a small macro-economic model showing aggregate resource constraints on North Korean defense spending and economic growth.

In the current work, three additional models have been developed to describe the economy of South Korea. The first is an I-O/LP model developed by KIDA in collaboration with the Korean Development Institute and with some assistance from Rand. This model is analogous to the I-O/LP model previously developed for the North Korean economy. It consists of 18 industrial sectors and 12 constraints, shown respectively in Tables 1 and 2. Investment and labor are allocated to each of these sectors to maximize discounted Gross National Product over a finite period, subject to the constraints shown in Table 2. It has more than 90 endogenous variables and more than 250 exogenous ones.

The second model is a "mini-macro economic model," developed principally by KIDA with some initial assistance from Rand. This model has 30 endogenous and 19 exogenous variables, with 30 equations, half of which are estimated and half are identities. The variables in the model are shown in Table 3.

The results obtained with these two models will be reported separately.

The third model—a small model of the South Korean economy (SMOKE)—was developed at Rand, and the simulations to be described later in this report are obtained by the use of this model.

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Table 1

SECTORS INCLUDED IN I-O/LP MODEL

1. Agriculture, forestry, and fisheries
2. Coal, coal products
3. Metallic ores, nonmetallic minerals
4. Food processing
5. Fabrics, textile products
6. Wood product and pulp
7. Basic chemicals
8. Chemical products
9. Petroleum products
10. Nonmetallic mineral products
11. Iron and steel products
12. General machinery
13. Electronic communication machinery
14. Transportation equipment
15. Building construction and maintenance
16. Electric power and gas, water service
17. Transportation and communication
18. Financing, real estate, and services

Table 2

CONSTRAINTS IN I-O/LP MODEL

1. Material balance constraints
2. Production capacity constraints
3. Inventory investment constraints
4. Savings and investment constraints
5. Foreign trade constraints
6. Import constraints
7. Domestic defense expenditure
8. Military operations and support cost constraints
9. Supply and demand of defense expenditure
10. Labor force constraints
11. GNP accounts
12. Terminal investment constraints

Table 3

VARIABLES IN MINI-MACRO ECONOMIC MODEL

Endogenous

Trade balance
Government capital consumption allowance
Private consumption expenditure[a]
Personal disposable income
Government military purchases from domestic defense industries[a]
Military expenditure[a]
Equilibrium Gross National Product
Demand side GNP
Supply side GNP[a]
Government fixed investment expenditure[a]
Private fixed investment expenditure[a]
Government fixed capital stock
Private fixed capital stock
Total capital stock
Total capital stock excluding defense industries
Total employment excluding defense industries
Total employment[a]
Labor force participation rate[a]
Aggregate import demand[a]
Real money demand[a]
GNP deflator[a]
Government revenue
Curb market interest rate[a]
Export unit price index[a]
Unemployment rate
General wage rate[a]
Total exports
Aggregate export demand excluding defense exports[a]
Defense industry output

Total output excluding defense industry output

Exogenous

Total capital consumption allowance
Private capital consumption allowance
Capital utilization rate
Exchange rate
Defense industry capital stock
Defense industry employment
Labor hour index
Total money supply
Residual national income categories
Government nontax revenue
Time deposit interest rate
Time
Total tax revenue
Unit price import index
Weighted average of prices in exporting countries
Exports by defense industries
World import volume
Population over 14 years
Dummy for 1980

[a]Endogenous variables determined in estimated equations.

B. WHY THREE MODELS OF THE SOUTH KOREAN ECONOMY?

Before describing SMOKE, it is worthwhile to explain why three different models have been developed for assessing the economic capabilities and prospects of the Republic of Korea.

One reason is that the several models can provide useful cross checks on one another. Since all three purport to describe the same economy, their predictions should be similar. If similar results in fact emerge, greater confidence can be placed in the results than if only a single model were used. If the results diverge, at least one model is not accurately describing the underlying economy. An attempt can then be made to understand and explain the discrepancies.

Also, each of the three models has a somewhat different purpose and capability. The I-O/LP model is designed to locate structural bottlenecks in the South Korean economy. Such bottlenecks are likely to be less important in the South than in the North, because South Korea is much more open to international trade and can consequently import its way out of most bottlenecks. Hence bottlenecks, if encountered at all, can be expected to arise in the nontraded sectors. Furthermore, because South Korea has a high investment share in national income, bottlenecks can be overcome fairly quickly in the nontraded sectors by concentrating investment there. The I-O/LP model should also be particularly useful if economic priorities change. For instance, a large defense buildup would impose costs unevenly across the South Korean economy. Of the three South Korean models, only the I-O/LP model can assess the sectoral impacts of such a buildup.

KIDA's mini-macro economic model is designed to predict a larger menu of economic trends than the I-O/LP model. It largely ignores differences across sectors that are central to the I-O/LP model. The mini-macro model predicts other economic variables that may affect the social and political cohesion of the South, which is another component of the long-term competition on the peninsula. For example, it predicts inflation, wage growth, and labor force participation. The mini-macro model also predicts likely trends in South Korea's trade balance, capital stock, and defense industrial output. However, it is less suited than the other two models to describe the consequences of such policy actions as a significant increase or decrease in military spending, because these are determined within the model itself rather than being subject to external policy determination.

C. A SMALL MODEL OF THE KOREAN
ECONOMY (SMOKE)

SMOKE is a small model of the Korean economy developed to estimate the effect of various levels of military spending on the South Korea economy through the year 1995. The model was reduced to 12 equations to bare its underlying mechanisms. Nonetheless, the essential links between the military sector and the civilian economy are included.

SMOKE is a supply model and, unlike many other forecasting models, does not address demand sufficiency. With a time horizon of more than a decade, cyclical effects will largely average out of the analysis. In any case, even the largest macroeconomic models predict cyclical fluctuations poorly over a period as short as one year and, for a 10-year period, such predictions are illusionary. SMOKE looks at long-run trends rather than short-term movements in key economic variables. Further, SMOKE is designed for policy analysis rather than forecasting.

Because SMOKE is a supply model, it focuses on the growth of factor inputs into the economy: increases in the labor force, capital accumulation, and technological progress. A trans-log production function combines these factors to determine production. This production function is the core of the model. As economic theory suggests, the wage rate is driven by the marginal product of labor in the production function. Similarly, investment decisions are affected by the marginal product of capital.

The defense sector of SMOKE is an accounting formula for the military budget. Manpower costs are calculated from force levels and a military wage that is some fraction of the civilian wage. Operation and maintenance (O&M) costs are a fraction of the existing military capital stock. Military investment is a direct expense but also adds to the military capital stock and therefore to future O&M costs.

The civilian economy in SMOKE is linked to the military sector in three ways. First, military wages are tied to civilian wages as described above. Second, military manpower reduces the pool of potential civilian workers. Finally, overall military spending reduces the resources available for civilian consumption or investment.

Foreign military sales (FMS) and other capital inflows are specified exogenously in SMOKE, and changes in Korea's terms of trade are reflected in the model's rate of technological progress through a time trend variable, which can be raised or lowered depending on whether Korea's terms of trade are assumed to improve or to worsen in the time period under investigation (1984-1994).

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The foreign trade sector of SMOKE is small. However, it captures, at a very aggregative level, many of the important ways that foreign trade affects Korea. The international sector will influence the Korean economy in two primary ways. The first is through a net inflow of resources. If Korea imports more than it exports, it receives a net flow of real goods and services. This capital inflow can be used for consumption, investment, or the military. In SMOKE, net inflows of capital are the sum of capital inflows except military (CAPXM) and new foreign military sales credits (FMS). The second effect of international trade is through increased efficiency. Foreign trade allows for specialization, other gains from trade, and the transfer of technology. Reflecting SMOKE's high level of aggregation, these factors, together with numerous domestic factors, are combined in the productivity coefficients in SMOKE's production equation. These coefficients can be adjusted upward, for instance, if oil prices fall (the economy might maintain the same level of technological efficiency, i.e., the same inputs and outputs, but its economic efficiency has increased, i.e., inputs are cheaper relative to outputs). Similarly, these coefficients can be adjusted downwards if oil prices rise, or if prices received for Korean exports fall.

SMOKE consists of 12 equations specifying, respectively, civilian capital stock, military capital stock, total employment, civilian employment, civilian production, civilian wages, military labor costs, gross national product, military operations and maintenance costs, defense spending, civil investment, and civil consumption. The dependent variables of these equations are the 12 endogenous variables in the model. Table 4 lists the endogenous and exogenous variables in SMOKE. Appendix A summarizes the equations and parameters of the model. A detailed exposition of the model is forthcoming.[1]

To validate SMOKE, we compared its predictions of historical values of key economic variables with their actual values. As shown in Fig. 1, SMOKE performs very well according to this criterion. The model's predictions of GNP never err by more than 11 percent of the actual GNP for any of the two decades covered in Fig. 1. For most of the period, SMOKE's predictions are still closer to the actual GNP values, thereby meeting a central concern for the model's purpose.[2]

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[1]See Donald P. Henry, *SMOKE: A Small Model of the Korean Economy*, The Rand Corporation, N-2381-NA, forthcoming.

[2]There are several ways to test the validity of an econometric model. Ideally, a model should be estimated over one period and then tested over a different period. If one estimates and tests over the same period, one naturally expects a good fit between actual and predicted values because, after all, providing a good fit is what econometric estimation does. Unfortunately, the size of the data sample is often too small to exclude some

Table 4

VARIABLES IN SMOKE

Endogenous
  Total employment
  Civilian employment
  Civilian capital stock
  Military capital stock
  Gross national product
  Wage rate
  Military labor costs
  Military O&M costs
  Total defense spending
  Consumption
  Investment
  Civilian government consumption

Exogenous
  Military manpower
  Military investment
  Net FMS credits
  Net capital inflows excluding FMS
  Time
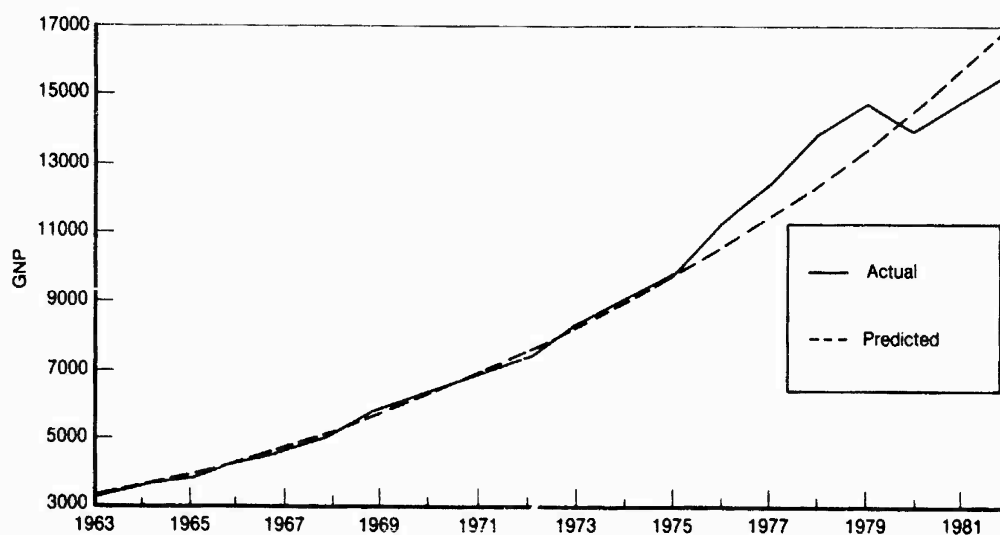
Fig. 1—Actual and predicted GNP

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SMOKE is used to simulate the effects (on GNP growth, consumption, and military burden) of alternative military force postures and their associated costs, as well as the effects of different assumptions about capital inflows, FMS, factor productivity, labor supply, and terms of trade on the future performance of the Korean economy. The results of these simulations are summarized in Sec. V, following our description in Sec. IV of the alternative force postures and their corresponding cost estimates.

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observations from the estimation process, and thereby to provide a separate test sample. This is the case with SMOKE, and the various measures we have used to test its historical performance are all based on the estimation time period.

IV. ALTERNATIVE FORCE POSTURES: DESIGN AND COST ANALYSIS

This section summarizes three widely differing ways in which South Korean forces might be structured in the next decade. In light of the objective of this study, the principal reason for designing these alternatives is to evaluate their respective effects on the performance of the South Korean economy and on the political and social stresses to which it would be subjected, depending on which of the alternatives is implemented. Section B summarizes the cost estimates of the alternatives,[1] which we then use as inputs to the economic model described in Sec. III above. The effects of the differing costs and spending estimates on performance are then analyzed in Sec. V, *Scenarios and Simulations*.

The three alternative force postures reflect differing strategic concepts for Korean forces. The alternatives differ in the total costs they entail, as well as in the military investment (nonrecurring) costs, and in the manpower and operations and maintenance (recurring) costs incurred during the 1984–1994 time period.

A. ALTERNATIVE FORCE POSTURES

The broad outlines of the alternative options can be generally characterized as follows:

1. **Alternative I, the base case,** is the present Korean force together with planned improvements to it. This force consists of 20 infantry divisions, two mechanized divisions, and associated supporting elements in the army, together with the present Korean air forces, the Korean navy, and two marine divisions. The total size of the Korean armed forces is about 640,000.[2]

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[1]Recurring military costs (manpower plus O&M) are endogenously determined within the model once military investment (nonrecurring) costs have been specified. Consequently, there are some differences between the recurring cost estimates made in SMOKE for these illustrative Korean force posture options, and the corresponding estimates made on a "building-block" basis by the separate cost analyses of each option, summarized in Section B below. These discrepancies are generally small, and do not affect the conclusions of the simulations summarized in Sec. V.

[2]See the International Institute for Strategic Studies, *The Military Balance, 1984-1985*, p. 103-104.

1. **Alternative II, an expanded counteroffensive force,** would increase the size of the base case force by about 25 percent, and would upgrade the quality and capabilities of South Korean forces to provide a credible counteroffensive capability in the event of an invasion from the North. The intended aim of creating such a credible counteroffensive capability, through the addition of an improved amphibious capability and associated supporting forces, would be to tie down a portion of the North Korean forces for the protection of North Korean territory, thereby reducing the North Korean forces available for offensive action. To the extent this intended aim was realized, the effect would be to reduce the concentration of forces and firepower at the DMZ, and thereby to contribute to greater deterrence and stability on the Korean peninsula.

3. **Alternative III, a high technology force,** is designed to trade off higher technology weapons, mobility, and equipment against a reduction of about 30 percent in active military manpower. The effect of this tradeoff is to add somewhat to force modernization costs, while saving on O&M costs. Although the O&M costs of the high technology force are appreciably lower than those of the base case (Alternative I), the investment costs of advanced equipment for Alternative III offset these savings. We had originally intended that the high technology force would have lower total costs associated with it, but procurement costs—even when spread over 10 years—precluded this.[3]

All of these alternatives for Korean forces assume that the size and composition of U.S. forces stationed in Korea remain as they are currently planned.

B. COST ANALYSIS

The incremental costs associated with each of the alternatives have been estimated on the basis of the following assumptions:

1. All of the costs are in FY 1982 U.S. dollars.[4]
2. Cost estimates for each alternative have been built up from separate component estimates for equipment procurement costs (nonrecurring), equipment O&M costs, and personnel costs for each service element in the three alternatives. The latter two components—O&M costs and personnel costs—have been combined into estimates of annual recurring costs for each of the alternatives.

[3]See Table 5.

[4]In the simulations described in Sec. V, these costs have been converted to 1984 dollars.

3. Cost estimates are based on U.S. equipment and personnel costs, with the following adjustments: equipment O&M costs for the Korean army and navy elements are estimated as 75 percent of the corresponding U.S. costs, whereas operating costs for the air force element are estimated as approximately 80 percent of U.S. costs; personnel costs for the army and navy elements are estimated as 25 percent of the corresponding U.S. costs. These adjustments are based on previous experience and comparisons of recurring costs in Korean and U.S. forces.

The resulting cost estimates for each of the alternatives are summarized in Table 5. The nonrecurring (investment) costs shown in Table 5 are assumed to be apread evenly over the 10-year period from fiscal 1984 through fiscal 1993. Annual recurring costs associated with each alternative would rise approximately in accord with the phasing of equipment acquisition, reaching the estimated steady-state level shown in the table by the year 1993.

Table 5

INCREMENTAL COST ESTIMATES AND SOUTH KOREAN POSTURE ALTERNATIVES, 1984–1993

(Millions of 1982 dollars, except as indicated)

Major Unit	Alternative I (Base case: current forces with Force Improvement Program)		Alternative II (Augmented counter-offensive force)		Alternative III (High technology force)	
	Nonrecurring Costs	Annual Recurring Costs	Nonrecurring Costs	Annual Recurring Costs	Nonrecurring Costs	Annual Recurring Costs
Army						
Personnel	128	128	193	696	0	-456
Equipment	11,668	1,582	20,240	2,352	18,517	1,296
Total	11,796	1,710	21,046	3,048	18,517	840
Air Force						
Personnel	113	1	129	1	96	-11
Equipment	3,771	-5	4,503	47	3,274	-35
Total	3,884	-4	4,632	48	3,370	-46
Navy						
Personnel	4	4	24	24	12	12
Equipment	2,610	45	3,317	181	3,133	173
Total	2,614	49	3,341	205	3,145	185
Total						
Personnel	245	133	849	721	108	-455
Equipment	18,049	1,621	28,210	2,579	24,924	1,462
	18,293	1,754	29,059	3,300	25,032	1,007
Total in FY84 dollars	19,700	1,900	31,300	3,600	26,900	1,100

NOTE: Figures have been rounded to nearest dollar from detailed estimates for the individual force and service components.

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Spreading procurement and associated personnel and operating costs of the three alternatives over a 10-year period reduces the incremental burden that the highest cost alternative (Alternative II, the expanded counteroffensive force) imposes each year on the South Korean economy. As a result, differences in the cost impacts of the three alternatives, and their resulting effects on the Korean economy, are moderated.

In the simulations described in Sec. V, estimates of the recurring (O&M and personnel) costs associated with each of the three alternative forces are estimated endogenously by SMOKE as a function of the military capital stock and military manpower, based on the coefficients of these variables, which are estimated econometrically from historical data.[5] This results in somewhat higher estimates for the final steady-state recurring costs than those shown in Table 5. The resulting SMOKE estimates of rising recurring costs in the 1983—1993 period for Alternative I are shown in Fig. 2.
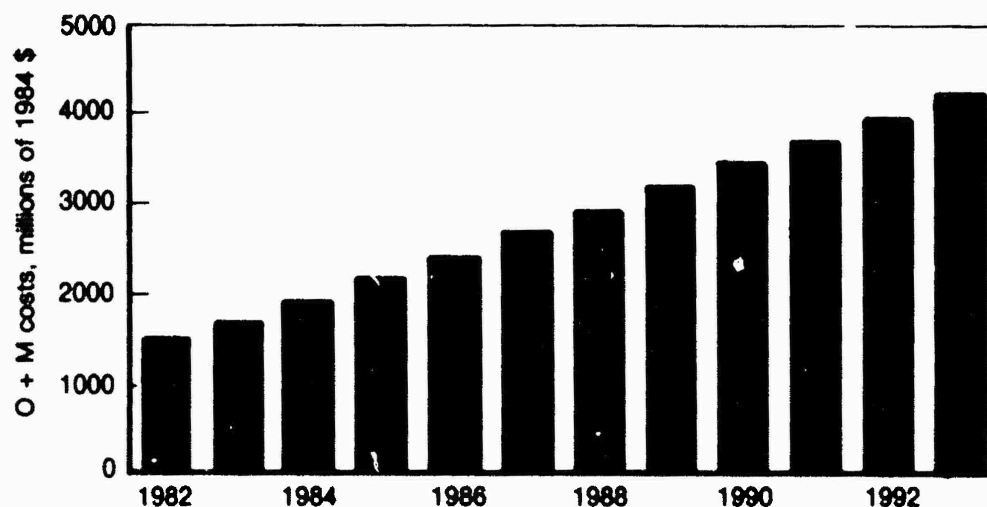
Fig. 2—Phasing of annual recurring costs for military option I*

*Estimated by Rand model.

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[5]See App. A, Eq. 9.

V. SCENARIOS AND SIMULATIONS

The following discussion primarily concerns forecasts of South Korea's economic performance during the period 1984 through the mid-1990s. These forecasts are based on SMOKE simulations, using the alternative military postures and their corresponding cost estimates described in Sec. IV, as well as on specified assumptions about other scenario elements relating to technological progress, labor supply, oil prices, and capital inflows. The section concludes with a summary of our updated forecasts pertaining to North Korea, for comparison with the South Korean results.

A. SOUTH KOREAN SIMULATION RESULTS

1. Economic Effects of Alternative Military Options

The effects of the three alternative force postures and their associated military spending estimates on South Korean GNP growth, civilian consumption growth, and the share of GNP represented by military spending are shown in Figs. 3, 4, and 5, respectively. In these scenarios, Korean military spending varies in accord with the three force postures, while other exogenous variables are specified at their baseline values: technological progress (growth in factor productivity) is set at 2.18 percent per year, reflecting its average value in the past decade; growth of labor supply is specified at 2.2 percent per year;[1] oil prices are assumed to be $30 per barrel; and capital inflows (including foreign military credits) are approximately $1.1 billion per year, reflecting recent years' experience.

As Figure 3 indicates, the alternative force postures have very small effects on South Korea's GNP growth. The difference in annual

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[1]The labor force growth assumptions used in these forecasts are based on a World Bank estimate of 2.2 percent annual growth through the rest of the century. The Korean government expects a 3 percent growth in labor supply over the medium term, but a 1.5 percent population growth during this period. Ultimately, of course, labor force growth will be constrained by the population growth rate. If the Korean labor force were to grow by, say, 3 percent through 1990, but by only 1.5 percent through 1995, the average growth rate will be 2.25 percent, which is very close to the World Bank estimate used in these forecasts. The only major difference between the two growth rate predictions is that the Korean economy would grow faster in the earlier years and slower in the later years using the Korean government's assumptions, compared with the assumptions used in the present study. By 1995, both scenarios produce about the same levels of income and consumption.
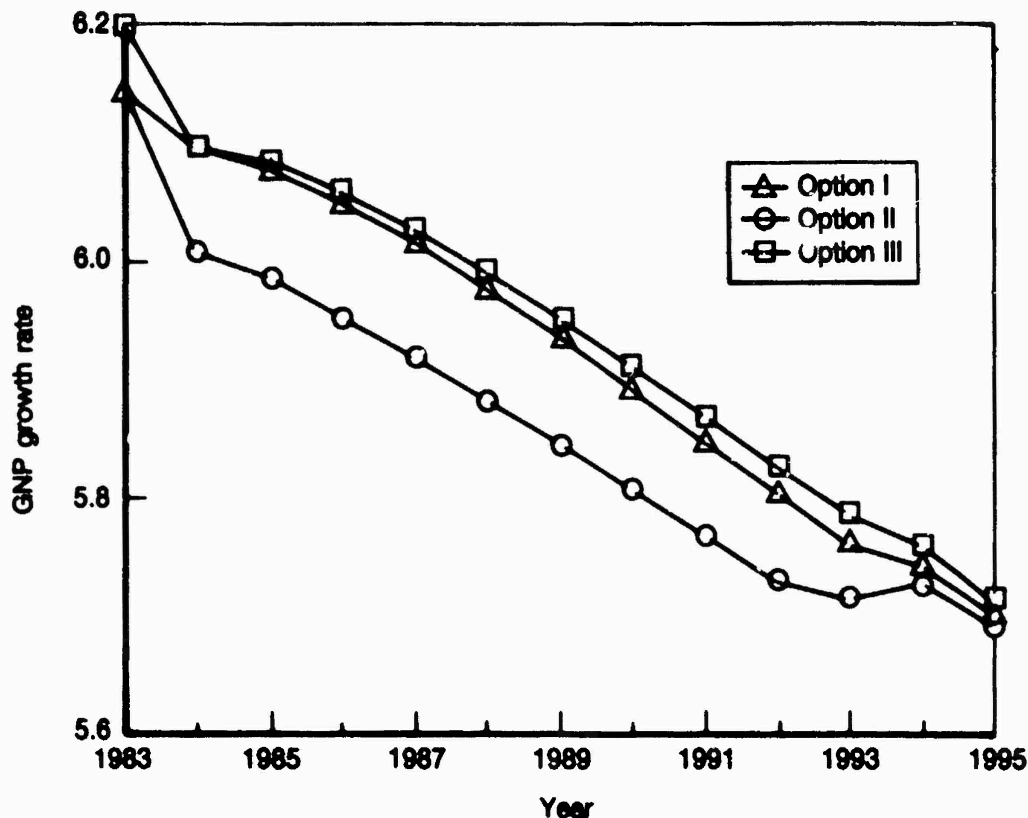
Fig. 3—GNP growth and military options

growth over the 1984–1994 decade is never more than 0.2 percent in any given year between the highest cost and lowest growth option (namely, Option II) and the two other higher growth and lower cost options, Options I and III. During the decade as a whole, South Korea's annual growth rates are never abovc 6.1 percent nor below 5.7 percent for any of the three options.

All three options are associated with a slightly declining trend in GNP growth over the decade, due principally to the same long-term influences: a reduced rate of growth in population and labor supply relative to the 1970s, and diminishing returns from additional capital investment in the economy as a whole.

The effects of the three alternative military postures on rates of growth in civil consumption are more differentiated than their effects on aggregate GNP growth. In effect, the higher investment costs, and the larger force size associated with Option II, boost military production and military consumption at the expense of civil consumption, but
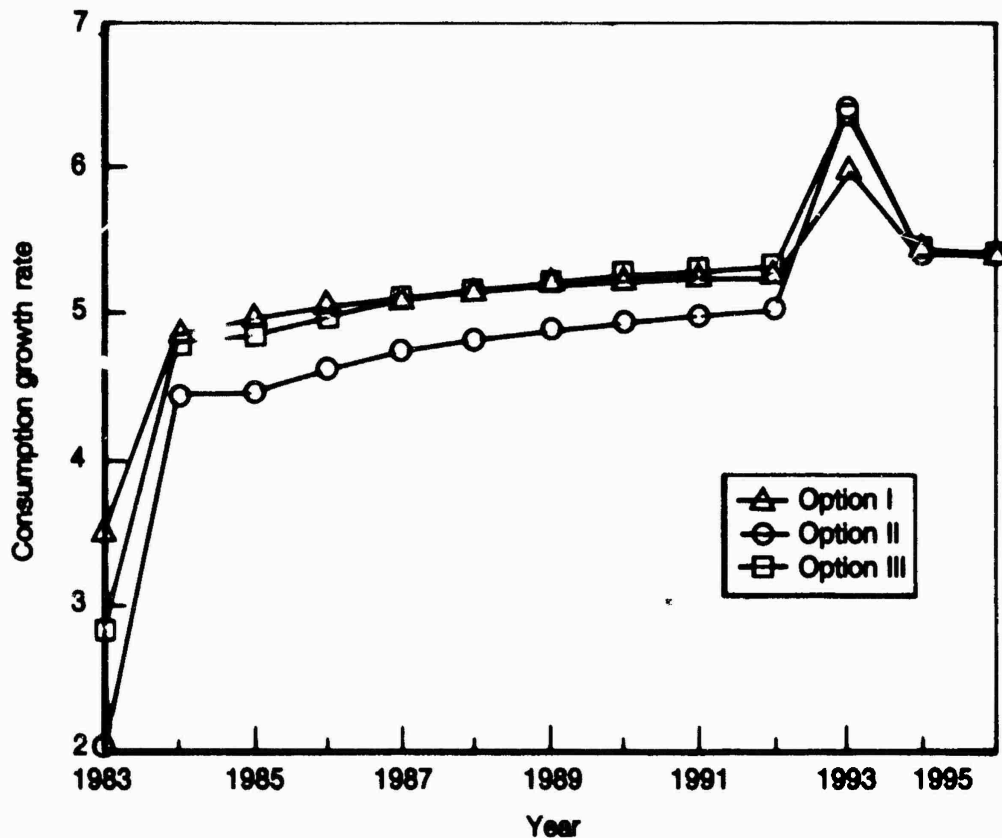
Fig. 4—Consumption growth and military options

without much effect on aggregate growth. For the 1984–1994 period, the higher military costs of Option II result in reducing civil consumption growth rates by 0.3 to 0.5 percent per year below the consumption growth rates associated with the base case Option I, and the high technology Option III. The lower cost Options I and III yield about equivalent rates of growth in civilian consumption, approximately 5 percent per year, whereas Option II results in consumption growth between 4.5 and 4.7 percent per year. If the forecast period were extended, consumption growth associated with the high technology-smaller force of Option III would surpass consumption associated with Option I, because of the productivity gains for the economy as a whole expected from the shifting of labor from the military in Option I to more productive employment in the civil sector under Option III. The sharp rise in consumption growth shown in Fig. 4 for 1993, for all three options, results from the completion in that year of their respective

military investment programs, thereby releasing resources for consumption purposes.

The most substantial differences among the options relate to the respective defense burdens they impose—construed as the ratio between military spending and South Korea's GNP. Figure 5 shows the differing burdens associated with the three military options.

In recent years Korea has been spending about 6 percent of its GNP on defense. As shown in Fig 5, all of the options result in higher defense shares than this benchmark. Options I and III vary between 7.5 and 8.4 percent of Korean GNP, with Option III toward the upper end of this range and Option I toward the lower end.[2] For the decade as a whole, the average military share is 7.3 percent for Option I, and
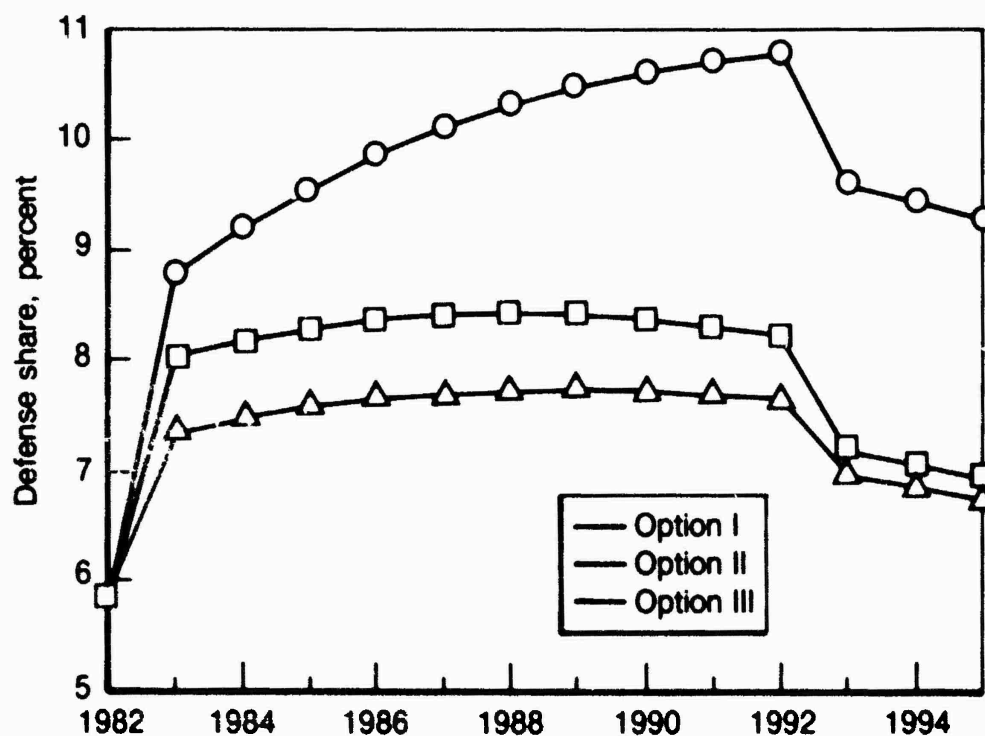
Fig. 5—Defense burdens and military options

[2]It is worth noting that our estimate for the baseline case, Option I (which represents the Force Improvement Program currently being implemented) shows a defense share of GNP that is a half percentage point above the reported shares in official Korean data for each of the past two years. This suggests either that the actual cost savings realized from the Force Improvement Program make our own cost estimates too high, or that savings from stretching out the program may be greater than we have allowed.

7.9 percent for Option III (see Table 6 below). In contrast, Option II, the counteroffensive alternative, results in a military share of GNP about two percentage points above the shares associated with Options I and III. Option III's defense burden ranges from about 9.2 to 10.8 percent of GNP over the 1984–1994 period, with an average of 9.6 percent for the period as a whole. In 1993, the defense burden drops for all three options, reflecting completion of their corresponding military investment programs.[3]

2. Effects of Exogenous Circumstances

Our simulations also sought to determine the effect of other circumstances, besides the three alternative military options and defense spending estimates, on South Korea's economic performance, and to compare these effects with those attributable to the differing levels of military spending. These other factors include technological progress, growth of Korea's labor supply, changes in oil prices and in Korea's terms of trade, and capital inflows and foreign military credits. To test the sensitivity of Korea's economic performance to these variables, we have assumed values for them substantially above and below the baseline estimates previously described. These "high" and "low" values have been selected to bracket the range we believe these variables will plausibly reach in the next decade.

- *Technological progress.* From 1963 through 1982, total factor productivity—that is, the ratio between the rates of growth in output and a weighted sum of capital and labor inputs—grew at a rate of 2.18 percent per annum. This impressive rate of productivity growth occurred as Korea became more fully integrated into the world economy. For example, exports in 1982 had risen to over one-third of GNP compared with a figure of less than one-eighth of GNP in 1963. South Korea's export-oriented growth strategy has more efficiently allocated labor and capital, which has contributed to the impressive growth of total factor productivity. Although exports may grow further as a percent of GNP, the productivity gains to be realized from such growth are probably small relative to what has been realized in the past. On the other hand, Korea may derive appreciable productivity gains from both the import of foreign

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[3] The annual costs of current U.S. ground and air forces in Korea are approximately $1.2 billion, equivalent to about 1.4 percent of Korea's 1985 GNP. The investment costs of these U.S. forces amount to an additional $4.0 billion. These costs are not reflected in the defense share estimates shown in Fig. 5.

Table 6

FORECASTS FOR ALTERNATIVE SOUTH KOREAN SCENARIOS[a]

Scenario	Option	Military Manpower[b]	Military Capital Stock[c]	Growth Rate of Productivity (percent)	Growth Rate of Labor (percent)	Capital Inflows[d]	Oil Price[e]	Growth Rate of GNP (percent)
Baseline forecast	I	622	29661.3	2.18	2.20	911	30	5.93
	II	783	42366.9	2.18	2.20	694	30	5.86
	III	434	37614.8	2.18	2.20	775	30	5.94
Productivity growth								
	I	622	29661.3	3.18	2.20	911	30	7.15
High	II	783	42366.9	3.18	2.20	694	30	7.08
	III	434	37614.8	3.18	2.20	775	30	7.17
	I	622	29661.3	1.18	2.20	911	30	4.71
Low	II	783	42366.9	1.18	2.20	694	30	4.64
	III	434	37614.8	1.18	2.20	775	30	4.72
Labor growth								
	I	622	29661.3	2.18	3.20	911	30	6.87
High	II	783	42366.9	2.18	3.20	694	30	6.81
	III	434	37614.8	2.18	3.20	775	30	6.89
	I	622	29661.3	2.18	1.20	911	30	4.98
Low	II	783	42366.9	2.18	1.20	694	30	4.91
	III	434	37614.8	2.18	1.20	775	30	5.00
Capital inflows								
	I	622	29661.3	2.18	2.20	2735	30	5.95
High	II	783	42366.9	2.18	2.20	2376	30	5.88
	III	434	37614.8	2.18	2.20	2394	30	5.97
	I	622	29661.3	2.18	2.20	-911	30	5.90
Low	II	783	42366.9	2.18	2.20	-1128	30	5.83
	III	434	37614.8	2.18	2.20	-1047	30	5.92
Oil prices								
	I	622	29661.3	2.18	2.20	911	40	5.67
High	II	793	42366.9	2.18	2.20	694	40	5.60
	III	434	37614.8	2.18	2.20	775	40	5.68
	I	622	29661.3	2.18	2.20	911	20	6.18
Low	II	783	42366.9	2.18	2.20	694	20	6.11
	III	434	37614.8	2.18	2.20	775	20	6.20
Best case								
	I	622	29661.3	3.18	3.20	2733	20	8.39
	II	783	42366.9	3.18	3.20	2376	20	8.33
	III	434	37614.8	3.18	3.20	2394	20	8.41
Worst case								
	I	622	29661.3	1.18	1.20	-911	40	3.49
	II	783	42366.9	1.18	1.30	-1128	40	3.41
	III	434	37614.8	1.18	1.20	-1047	40	3.51

Table 6—continued

GNP in 1995	Growth of Civil Consumption (percent)	Civil Consumption in 1995	Average Defense Share of GNP (percent)	Maximum Defense Share of GNP (percent)	Defense Spending in 1982	Defense Spending in 1994	Average Defense Spending, 1982–1994
159727.4	5.10	96048.7	7.3	7.7	4432.1	10359.3	8124.8
158429.7	4.78	92373.2	9.6	10.8	4432.1	14138.5	10684.8
160076.1	5.08	95852.0	7.9	8.4	4432.1	10689.8	8721.7
185387.8	6.30	111327.1	7.1	7.5	4432.1	11041.8	8406.6
183965.5	6.01	107425.0	9.2	10.0	4432.1	14996.3	11025.4
185848.8	6.30	111337.8	7.5	8.2	4432.1	11166.0	8934.3
137414.7	3.90	82716.7	7.7	8.2	4432.1	9763.3	7869.0
136231.2	3.55	79241.7	10.1	11.6	4432.1	13390.1	10376.1
137668.3	3.86	82343.3	8.3	8.9	4432.1	10657.1	8528.2
179354.8	6.01	107546.2	6.9	7.4	4432.1	10286.0	8081.6
178004.0	5.73	103841.2	9.0	9.8	4432.1	14047.5	10633.4
179695.2	6.00	107320.5	7.4	8.1	4432.1	10640.2	8688.9
142101.8	4.17	85587.5	7.8	8.4	4432.1	10857.8	8169.9
140856.7	3.82	81939.4	10.2	11.8	4432.1	14234.6	10738.1
142458.7	4.15	85421.8	8.3	9.0	4432.1	10742.6	8756.3
160210.9	5.24	97747.9	7.3	7.7	4432.1	10377.5	8136.2
158928.5	4.93	94076.9	9.6	10.7	4432.1	14162.2	10698.5
160563.8	5.22	97558.0	7.9	8.4	4432.1	10703.0	8730.8
159234.5	4.95	94343.7	7.3	7.7	4432.1	10340.2	8113.4
157920.7	4.63	90663.5	9.6	10.8	4432.1	14113.9	10670.7
159578.8	4.93	94140.0	7.9	8.4	4432.1	10676.6	8713.0
154710.3	4.82	92864.4	7.5	7.9	4432.1	10210.9	8021.9
153428.5	4.50	89229.1	9.8	11.0	4432.1	13951.9	10564.2
155033.4	4.80	92621.2	8.0	8.6	4432.1	10586.5	8640.2
164772.3	5.36	99255.5	7.2	7.6	4432.1	10506.6	8229.1
163458.6	5.05	95539.7	9.4	10.6	4432.1	14326.6	10806.4
165146.6	5.35	99105.8	7.7	8.3	4432.1	10794.1	8804.1
215426.2	7.40	130606.3	6.5	7.2	4432.1	11150.6	8486.3
213947.3	7.15	126633.0	8.5	9.2	4432.1	15157.9	11118.2
215914.7	7.41	130648.2	6.9	7.8	4432.1	11243.4	8998.5
118057.8	2.53	69608.3	8.3	9.2	4432.1	9684.6	7804.3
116923.5	2.13	66191.1	11.0	13.0	4432.1	13289.4	10301.0
118294.8	2.48	69217.5	9.0	10.0	4432.1	10218.2	8475.8

[a]All figures in millions of 1984 U.S. dollars unless otherwise noted.

[b]Military manpower in 1000s.

[c]1995 military capital stock.

[d]Annual average capital inflows.

[e]1984 dollars per barrel.

technology and domestic financial liberalization, as well as financial integration in international capital markets.

Our previous forecasts have assumed a continuance of the 2.18 percent annual rate of growth in productivity over the next 10 years. One can as plausibly assume that this growth rate will rise in the future as that it will fall. To bracket these alternative assumptions, we assume an annual rate of growth in technological progress of 3.18 percent on the high side and 1.18 percent on the low side.

As indicated in Table 6, these alternative assumptions about productivity growth have much greater effects on Korea's economic performance than those that result from different levels of military spending. For example, as shown in the table, annual GNP growth rate is 1 percent greater during the next 10 years if the growth of productivity is on the high side, whereas Korea's annual GNP growth rate is more than 1 percent below the baseline assumption if productivity growth is on the low side. Furthermore, the difference in annual GNP growth over the 10 year period is nearly 2.5 percent per annum depending on whether high or low productivity growth is assumed. Similarly, annual consumption growth rises by more than 1 percent if productivity growth is on the high side, and falls by more than 1 percent if it is on the low side.

Most of these marked differences in GNP and consumption effects are directly due to the higher or lower assumptions about productivity growth. A small part of the differences results from the indirect effect of higher or lower productivity growth on investment: higher productivity growth encourages additional investment, which augments the original productivity effect, while lower productivity growth has the opposite result.

- *Growth in labor supply.* In one sense, growth of the labor supply in Korea should be fairly easy to forecast, because every member of the labor force in 1995 is alive today. Thus, variations in population growth will have little effect on the labor force. However, labor force participation patterns may change drastically over the next decade. Women may enter or leave the labor force in larger numbers as social attitudes evolve and economic opportunities change. Also, a sizable number of overseas Koreans might return as the Korean economy grows.

Table 6 shows the effect on income and consumption growth rates of changes in labor force growth rates by 1 percent above

or below the 2.2 percent annual labor supply growth assumed in our baseline forecast. A 1 percent increase or decrease in the growth of Korea's labor supply raises or lowers the growth rate of income and consumption by slightly less than 1 percent because the changes in the labor input are assumed to occur without corresponding changes in other inputs. Consequently, there are diminishing (or, in the case of reduced growth of labor supply, increasing) marginal returns to labor. Although higher (lower) labor growth rate induces additional (reduced) investment, the resulting changes in investment are not sufficient for income growth and consumption growth to keep pace with the growth of labor supply.

- *Terms of trade and oil prices.* Since there is no foreign trade sector in SMOKE, terms of trade changes show up in the productivity parameter of the model. An adverse shift in the terms of trade thus shows up as decreased efficiency in converting factor inputs to economically valuable products—that is, a fall in the rate of growth in total factor productivity. For example, Korea is a major energy importer. If energy prices rise, Korea must give up more of its production to pay for energy imports. As a result, there is a decline in its economic efficiency in converting inputs into value-added. In 1983, oil prices were roughly $30 per barrel (of Saudi marker crude), and Korea imported $5.5 billion of crude oil. If oil prices rose to $40 a barrel, then the same oil would cost $7.3 billion, and Korean GNP would have been $1.8 billion lower, a 2.5 percent decline. In general, each dollar increase (decrease) in oil prices, lowers (raises) the technological coefficient by one quarter of 1 percent. If oil prices fall to $20 a barrel, Korean GNP would be increased by about 2.5 percent.

As Table 6 indicates, the effects of higher or lower oil prices on rates of growth in Korean GNP and Korean civil consumption are greater than the effects of the alternative military spending options described earlier. Thus, if oil prices are at the $40 per barrel level, South Korea's annual GNP growth will be about 0.3 percent below what it would be at a $30 a barrel level; if oil prices fall to $20 a barrel, Korean GNP growth will be about 0.3 percent higher than at the $30 a barrel price, and about 0.5 percent higher than at the $40 a barrel price, assuming other factors remain constant. By the mid-1990s, the difference between high and low oil prices will be reflected in a 6 or 7 percent difference in the levels of Korean GNP and civil consumption.

Similarly, appreciable effects on the economy's performance would ensue from a growth of protectionism in the developed world. The result would be a reduction in Korea's ability to sell in international markets. Korea would have to export more of its current production to pay for needed imports. As in the case of higher prices for oil imports, this would be reflected as a decline in the Korean economy's efficiency, a fall in the productivity parameter of the model, and a lower rate of growth for the economy as a whole.

The general point is that changes in the volume and terms of trade—whether through changes in oil prices or in protectionism in world markets—are likely to have greater effects on Korean economic performance than those resulting from alternative military spending levels.

- *Capital inflows.* To test the effect of capital inflows on Korean economic performance, we varied the assumed annual level of such inflows over a range of approximately $3.5 billion (covering an annual inflow of between $2.4 and $2.7 billion and an annual *outflow* of about $1.0 billion) for the three military options over the 1984–1994 period. This range encompasses a variation of over $1 billion per year above and below the capital inflows assumed in the baseline scenario.

The results are summarized in Table 6. According to the SMOKE simulations, alternative assumptions about nonmilitary capital inflows within these ranges have a very limited effect on Korea's economic performance. As indicated in the table, the resulting effect on annual GNP growth is almost imperceptible (about 0.05 percent), and the effect on civil consumption growth is only 0.3 percent per annum.

There are several reasons for these small effects. One is that the model assumes that only 30 percent of capital inflows actually contribute to increased Korean capital formation, whereas 70 percent of inflows simply raise civil consumption. Another reason for such limited effects is that changes of this scale in capital inflows are very small in relation to the total Korean capital stock—averaging less than 1.5 percent of the capital stock in each year of the period. However, an important qualification should be added to this point: to the extent that capital inflows embody technological change, these, in turn, could have a more substantial impact on changes in productivity in the Korean economy, and hence on its overall performance.

These effects are not captured by the model, and represent one of its major limitations.

- *Foreign military credits and sales.* To evaluate the effects of FMS, their annual levels are assumed to vary between 220 and 540 million for the three options (the higher end of the range applies to Option II, the lower end to Option I) over the 1984–1994 period. Changes in the flow of foreign military credits within this range also have a small effect on economic performance, according to the SMOKE simulations. This is partly for the same reason that applies to capital inflows, and partly because of the additionality coefficient connected with FMS: only part (60 percent) of FMS is construed as adding to Korean capital inflows, whereas the remainder is assumed to replace nonmilitary capital imports.

- *Combination scenarios.* It should be evident that the assumptions used in our baseline forecast are subject to considerable uncertainty. To show the possible range of performance outcomes, we have constructed "best case" and "worst case" scenarios. The "best case" scenario consists of high productivity growth, high labor growth, high capital inflows, and low oil prices, whereas the "worst case" scenario reverses these assumptions, assuming instead that low productivity growth, low labor growth, low capital inflows, and high oil prices prevail.

As indicated in Fig. 6 and in Table 6, the effect of this packaging of assumptions is quite dramatic: GNP grows at 8.4 percent in the "best case" and at only 3.5 percent in the "worst case." Annual consumption growth is 5 percent higher in the "best case" scenario than in the "worst case" scenario and, by the mid-1990s, consumption levels are about 90 percent higher in the "best case" than in the "worst case."

Clearly, packaging the several different exogenous circumstances has an overwhelmingly greater effect on the performance of the Korean economy than the alternative assumptions about defense postures and military spending levels.

3. Effects of Decreased Military Spending

As already indicated, each of the three alternative options would result in increases in South Korean military spending, as well as increases in the commonly accepted 6 percent share of GNP allocated to Korean defense in recent years. In discussions with us, our KIDA
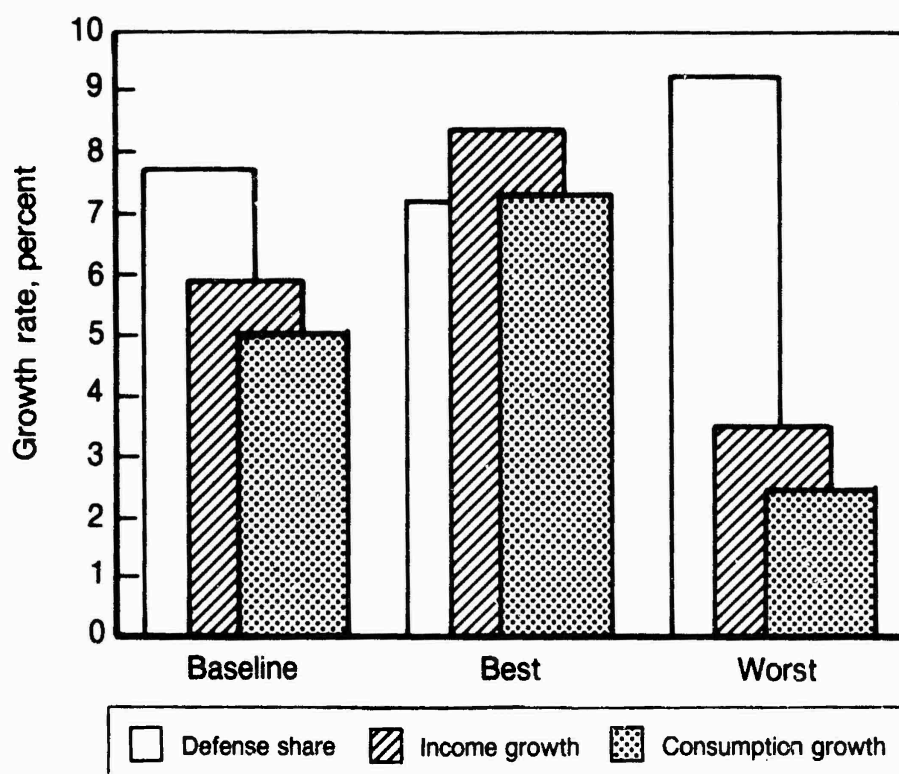
Fig. 6—Best and worst cases

colleagues reemphasized the importance of this 6 percent threshhold in established Korean budgeting and planning processes.

Reflecting these discussions, and to balance the previous analysis of the economic effects of increased military allocations, it is appropriate to consider the effects of reduced military allocations as well. Toward this end, we have used SMOKE to evaluate the effects on GNP and consumption growth of varying the military spending share over a wide range. Independent of the three military options discussed earlier, we considered two different methods for changing the military share in Korean GNP: the "capital augmenting" (or "capital-saving") method maintains military manpower at the current 630,000 level, and changes the defense share by raising or lowering military investment; the "labor augmenting" (or "labor-saving") method maintains military investment at current levels, and changes the defense share in GNP by raising or lowering military manpower.[4] The results of this analysis are shown in Figs. 7 and 8.

As Figs. 7 and 8 indicate, reductions in the defense share have only minor effects on aggregate economic performance. Reducing the

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[4]For a more detailed exposition, see Henry, forthcoming.

defense share from 6 to 4 percent would increase Korean growth by less than one-tenth of one percent per year, regardless of whether the capital-saving or labor-saving method is adopted; the resulting increase in consumption growth would be slightly greater—but less than three-tenths of one percent per year.

B. UPDATING OF NORTH KOREAN SIMULATION RESULTS

To provide a basis for comparison with the South Korean simulations, we adjusted our previous forecasts of North Korean economic performance to make them more current:

1. Our 1982 estimates of North Korean military manpower costs were believed at the time to be too low, although they were based on the only data then available to us. More recent information suggests that North Korean per capita military personnel costs are about one-fourth those of the South (hence, slightly less than the ratio of their per capita GNPs). On this assumption, we have reestimated personnel costs for the North Korean military as 15 times what they were in the
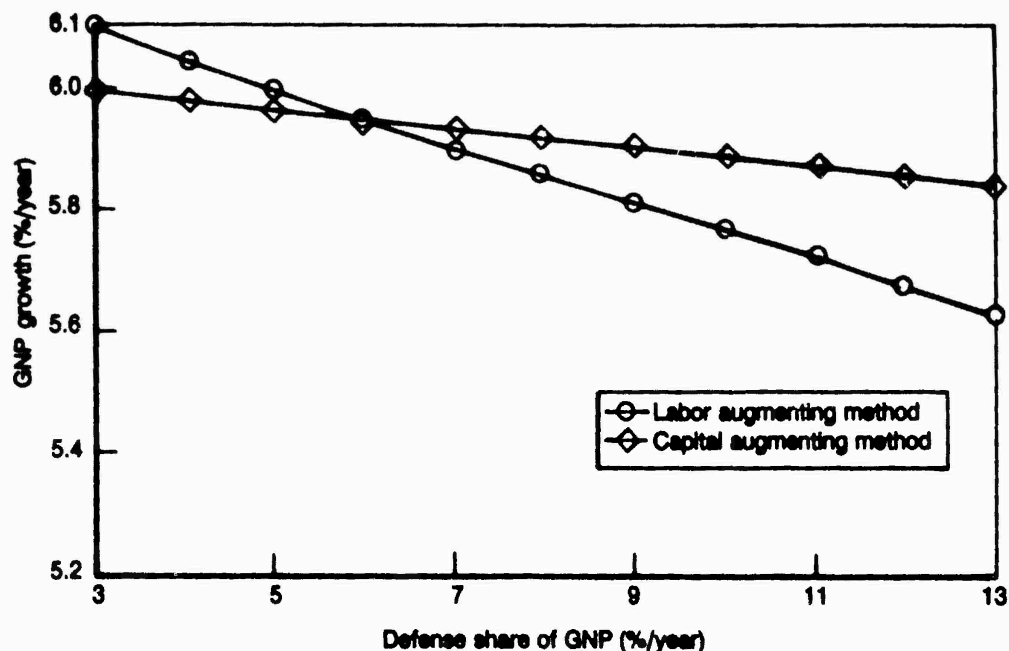
Fig. 7—Effects of South Korean defense spending on GNP growth

previous report. This recalculation of manpower costs results in an average increase in North Korea's total military spending (including procurement and O&M, as well as personnel costs) of about 22 percent for the period from 1978 to 1994.[5]

2. This increase in manpower costs has been added to our earlier estimates of North Korean GNP. Hence, the ratio between North Korean defense spending and GNP is higher than in the earlier report. We assume that annual growth rates of both GNP and military spending remain what they were in our previous simulations.

3. All of the estimates that were originally in 1978 dollars have been converted to 1984 dollars.

The results of these recalculations are summarized in Table 7. The scenarios for which these recalculations were made were selected from scenarios in our earlier North Korean study to bracket the range of performance outcomes.

As Table 7 indicates, North Korean GNP for the period from 1982–1994 is estimated to grow at a rate between 2.3 and 3 percent per
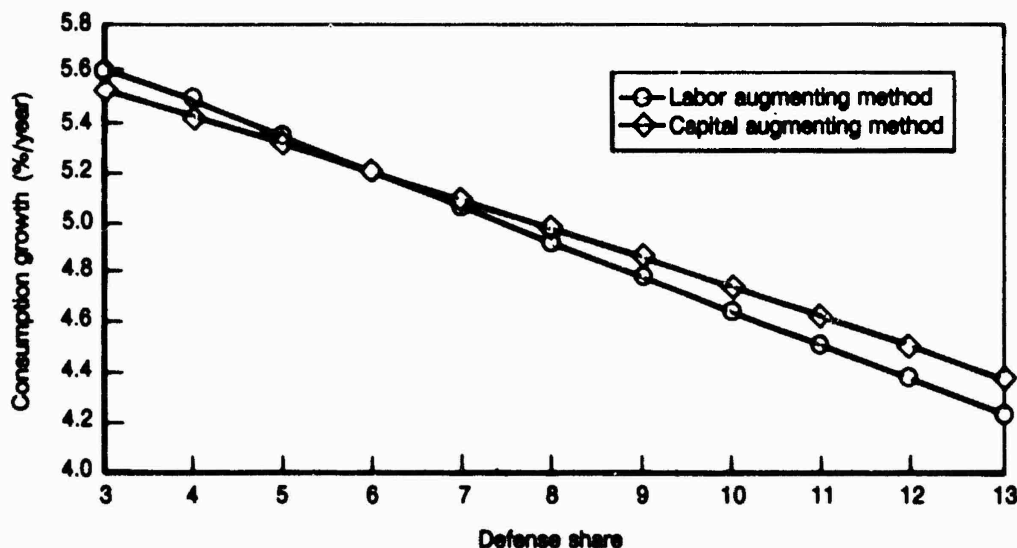
Fig. 8—Effect of South Korean defense spending on consumption growth

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[5]John Schank, "Updated North Korean Military Personnel Costs," January 18, 1985 (internal memorandum). The reestimates assume that North Korean military pay per man is between one-third and one-fourth that of South Korea, while South Korean military pay is about one-fifth that of the United States.

Table 7

UPDATED ESTIMATES OF NORTH KOREAN ECONOMIC
AND DEFENSE AGGREGATES, 1982-1994[a]
(Dollar figures in billions of 1984 dollars)

| | Scenario | | | | | | Results | | | | | | |
| | | | | | | | GNP | | Military Expenditures | | | | |
Initial Year (1982) (Bil. $)	Consumption Share of GNP(%)	Consumption Growth Rate (%/yr)	Export Growth Rate (%/yr)	Import Growth Rate (%/yr)	Labor Growth Rate (%/yr)		Final Year 1994 (Bil. $)	Growth Rate (%/yr)	Initial Year 1982 (Bil. $)	Average Annual (1982-1994) (Bil. $)	Average Percent of GNP (%)	Growth Rate (%/yr)	Final Year (1994) (Bil. $)
1. 14.0	62.5	3.0	7.5	8.5	2.0		18.7	2.5	4.0	4.4	27.4	1.6	4.8
2. 21.4	62.5	3.0	7.5	8.5	2.0		28.8	2.5	4.0	4.2	17.0	1.1	4.5
3. 16.4	75.0	3.0	7.5	8.5	2.0		18.4	2.5	4.0	4.3	24.2	1.0	4.5
4. 21.0	62.5	3.0	7.5	5.0	2.0		27.5	2.3	3.6	3.1	13.1	-2.7	2.6
5. 17.4	62.5	3.0	7.5	8.5	2.5		28.4	3.0	4.2	5.3	24.5	3.5	6.3
6. 17.6	62.5	2.0	7.5	8.5	2.5		25.2	3.0	4.8	7.1	32.2	5.8	9.3

[a]Data derived from previous estimates. All dollar figures were converted to 1984 dollars using the U.S. GNP deflator.

annum, compared with rates between 5 and 7 percent shown in the simulations for South Korea. Consumption growth for North Korea ranges between 2 and 3 percent annually over the period, and the defense-to-GNP ratio ranges from a fairly low level of 13 percent to a high figure of 32 percent in the scenarios summarized in the table.

Finally, average annual military spending over the 12-year period ranges from $3 to $7 billion, in 1984 dollars, for the several scenarios; average military spending for the six scenarios is $4.7 billion. These North Korean military spending estimates are between one-half and two-thirds of those in our estimates of real military spending for South Korea for the corresponding period.

C. COMPARING SOUTH KOREAN AND NORTH KOREAN RESULTS

Table 8 summarizes the salient results of the simulations for South and North Korea. Although forecasts 10 years in the future must be treated with circumspection, the comparisons between North and South Korea resulting from the two sets of simulations are striking.

By 1994, South Korea's economy, in the aggregate, is estimated to be between six and seven times that of North Korea. Its annual military spending, in terms of 1984 U.S. dollars, will average between 50 percent more than, and over twice as large as, that of the North, during the period between 1982 and 1994. And by 1994, its annual level of military spending will reach between 70 and 200 percent above that of the North.

Table 8

SIMULATION RESULTS FOR SOUTH AND NORTH KOREA

(Dollar figures in billions of 1984 dollars)

	North Korea	South Korea
GNP		
Annual growth rate, 1984–1994	2-3%	5-7%
1994 level	$18–29	$136–186
Military spending		
Average annual, 1982–1994	$ 3–7	$ 8–11
1994	$ 3–9	$ 10–15
Average share of GNP, 1984–1994 (%/year)	13-32%	7-10%

VI. SOME RELATED ISSUES: CIVIL SUPPORT FOR MILITARY COMPETITION, COMPARATIVE SOUTH-NORTH SPENDING, AND AGRICULTURAL SUBSIDIES

There are several important issues that cannot be dealt with in our formal modeling efforts. We consider three in this section: civil support for military competition, the paradox of relative military expenditures in North and South Korea, and agricultural subsidies in South Korea.

The principal focus of the discussion is on South Korea, with comparative treatment of the North where relevant and where available information permits such an extension. For each of these related issues, our purpose is to explore the subject in a preliminary way. Constraints or both data and time preclude more intensive examination.

A. CIVIL SUPPORT FOR SOUTH KOREA'S MILITARY COMPETITION

During the past 20 years, the South Korean economy has grown five to sixfold. The comparable growth for North Korea is no more than half as large. This dramatic growth in size, as well as in technical sophistication and complexity, confers several significant advantages on the South in its competition with the North. These advantages have been insufficiently taken into account in assessing South Korea's capabilities for long-term competition with the North. Consequently, there is probably considerable room for exploiting these potential advantages in the future.

Four principal aspects of these advantages are discussed below.

1. *Mobilization capability.* South Korea's gross national product is four to five times as great as that of North Korea. Its capacity to mobilize resources to support its military effort is correspondingly greater, provided sufficient warning time exists for the advantage to be fully exploited.

If one compares output outside the military sector, the South has more than a fivefold advantage over the North.[1] If North Korea shifted 5 percent of its nonmilitary output into the military sector, the South could match the shift using only 1 percent of its nonmilitary output. Such shifts from the civil to the military sector can be important in two respects: in peacetime, such a shift might permit abrupt and sizable additions to South Korea's order of battle, thereby altering the military balance; in wartime, such shifts might augment and resupply the combat forces—again assuming that the war is sufficiently protracted for the shift to be made.

In addition to the size of the South Korean economy, the composition of its output confers a further advantage over that which can be drawn upon by the North. In general terms, nonagricultural output is more likely to be directly transferable to military support purposes than is agricultural output. If one looks only at nonagricultural output, the South has a still greater advantage over the North. In 1981, for example, only 17 percent of South Korea's national income was from agriculture.[2] Although comparable figures for the North are not available, nearly 50 percent of the labor force in the North was involved in rural activities in 1982,[3] and at least 35 percent of North Korea's output is agricultural. Consequently, if one combines the nonagricultural and nonmilitary output of the two Koreas to estimate the relative mobilization capabilities of the two sides, the South is at least seven and a half times larger than the North.

A larger and more technically trained labor force in the South provides another advantage for its mobilization capability compared with that of the North. The South Korean labor force has about 15.7 million workers, compared with the North Korean figure of about 8.4 million.[4] This advantage is increased if only civil workers are counted, a more appropriate indicator because mobilization opportunities depend on labor that is available for induction into the military.

Finally, and more arguably, South Korea's economic organization and structure is probably more adaptable to surges in military output and reductions in the civil labor force because the South Korean economy is market oriented, whereas the economy of the North is

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[1]See Arms Control and Disarmament Agency, *World Military Expenditures and Arms Transfers, 1972-1982*, April 1984, Table I, p. 33.

[2]World Bank, *World Development Report*, 1983, Table 3, p. 153.

[3]*The Far East and Australasia, 1984-1985*, Europa Publications Ltd., London, 1984, p. 509.

[4]For the North Korean estimate, see Food and Agricultural Organization, *Production Yearbook*, cited in *The Far East and Australasia, 1984-1985*, p. 519. For the South Korean figure, see *The Far East and Australasia, 1984-1985*, p. 527.

centrally planned. Market economies are generally more flexible in dealing with changing circumstances, although disruptions in a market economy could be substantial after a major shift of resources toward the military. These disruptions are likely to be even more severe in a centrally planned economy: for example, schedules and quotas not met in one sector might very well cascade into reduced production throughout the economy. Nevertheless, the South's potential advantage on this count is more arguable. Command economies, such as that in the North, possess advantages in this sort of contest because the political constraints they face in bringing about resource shifts may be less than those confronting more pluralistic and competitive systems.

2. *Order of battle augmentation.* Besides South Korea's substantial macroeconomic advantages in its ability to provide generalized resources for mobilization purposes, the South has an overwhelming advantage in the availability of specific civilian assets that can be converted into military uses on short notice. Examples include civilian vehicles, airlift, shipping, maintenance facilities, and engineering and construction capabilities.

At the end of 1983, South Korea had over 300,000 civilian trucks.[5] A suitable contingency plan to convert, say, one-third of these vehicles to military surface lift would double the present vehicle fleet of the Korean armed forces. Moreover, support for these vehicles (fuel, spare parts, service facilities, and mechanics) is already in place in the civilian economy. Although we do not know the precise numbers of non-military vehicles in North Korea, it is clear that the North's ability to draw on a similar reserve pool of surface lift does not come close to matching the South's capabilities.

South Korea's civil air fleet (Korean Air Lines) includes 37 jet aircraft, mainly wide-bodied 747s, DC 10s, and A-300 airbuses.[6] Their combined lift capability is about 2000 metric tons, roughly two and a half times that of the Korean air force's C130s and C123s.[7] This airlift can be augmented further by the smaller aircraft used by KAL for internal transportation within Korea. These combined capabilities could provide a substantial augmentation to the Korean air force air fleet. For example, KAL's larger aircraft could ferry essential supplies into Korea from abroad to make up for the probable reluctance of foreign air carriers to fly into a combat or crisis zone. However, foreign carriers could bring cargo to Japan or to Cheju Do, and KAL's

[5] *The Far East and Australasia, 1984-1985*, p. 532.

[6] Korean Overseas Information Service, *A Handbook of Korea*, Seoul, 1982.

[7] *Jane's Fighting Ships, 1984/85*, Jane's Publishing Co., Inc., New York, pp. 310-317.

wide-bodied jets could then fly supplies to the peninsula. Furthermore, the smaller civil aircraft would not be restricted by runway constraints as would the larger civil aircraft, and so could be used to move supplies and personnel quickly within South Korea.

Mobilization of, say, one half of the KAL civil fleet would more than double the current airlift capabilities of the Korean air force. As in the case of the civil trucking fleet, KAL already has maintenance personnel, fuel, and spare parts in place to provide support for this conversion. By contrast, North Korea has virtually no civil air fleet that it can draw on to augment its military air order of battle.

Another source of augmentation for South Korea's military capabilities lies in the enormous volume of its civilian merchant marine compared with that in its navy. South Korea has over 5 million dead weight tons in its merchant fleet, more than 10 times that of North Korea, and about 100 times as large as the sealift capabilities of the South Korean navy.[8] Contingency plans to use, say, one-third of this total to move troops, equipment, and supplies in a conflict or crisis would constitute a substantial increment to the effective capabilities of the Korean armed forces. Such capabilities could be especially useful in providing support for the second military posture alternative described in Sec. IV, which includes a credible counteroffensive and amphibious capability within the South Korean military establishment. As with the civil surface and airlift capabilities, the civil sealift is supported by its own repair and maintenance vessels, as well as by shore establishments.

As suggested by the foregoing discussion of surface, air, and sealift capacity, the corresponding maintenance facilities can provide additional support for the military's own transport capabilities. Civil maintenance facilities, which are much greater than those within the military itself, as well as much greater than those in the civil sector of North Korea, would be able to provide backup support for the repair and maintenance of military equipment and facilities in a conflict contingency. Maintenance facilities for civilian cars and trucks might, for example, provide repair facilities for military vehicles. As a rough estimate, the civil facilities should be able to augment existing maintenance and repair capabilities within the military by a multiple of two or three times.

Finally, South Korea has a large, world-class engineering and construction industry able to compete in the international market with the highest quality and most efficient engineering and construction firms of Western Europe and the United States. Nearly all of the man-

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[8]*Jane's Fighting Ships.*

agement and work force in this field have served in the Korean military. There are approximately 60,000 Korean construction workers in the Middle East alone,[9] and the total manpower employed in the Korean construction industry is, larger than the 600,000 members of Korea's armed forces as a whole.[10] Utilization of, say, 20 percent of the construction and engineering capability in the civil sector would thus augment by tenfold the engineering and construction battalions now in the active Korean armed forces.

3. *Peacetime cost savings and subcontracting.* Because the South Korean economy is so much larger and more technologically and organizationally advanced than that of the North, the civilian sector can efficiently meet peacetime military needs to a considerably greater extent than is possible in the North, and probably to a considerably greater extent than has already been recognized in South Korea itself. Although we have only scratched the surface of this issue here, several examples illustrate the point:

- As noted earlier, the civilian truck and vehicle fleet is six times larger than the military vehicle fleet, and consequently civilian maintenance, repair, and rebuild capabilities for vehicles are much larger and probably more efficient than those indigenous to the military. It would be worthwhile to explore the extent to which contracting out to the civil sector by the military for these services would be more efficient, especially for major rebuild and repair needs, and what the resulting peacetime cost savings would be.

- Since the Korean shipbuilding industry is now a world-class competitor, the Korean navy should be able to draw on it for comparable maintenance, repair, and rebuild services, as well as for new construction of naval vessels. Again, we have not had an opportunity to explore the extent to which use is already made of these civil capabilities, but the scope for efficiently using them in peacetime may be considerably greater than is being exploited by the Korean navy.

- As already noted, the Korean construction and engineering industry is an effective competitor in international markets. Consequently, it would seem likely that the military can draw on civil industry during peacetime for a wide range of construction and engineering services in connection with road building, bridge building, port construction, airfield construction, and

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[9]Douglas Ramsey, "From Rags to Riches," *The Economist*, March 3, 1979, Survey Section, p. 4.

[10]International Labor Organization, *Yearbook*, Geneva, 1984.

aircraft sheltering. It should be possible to use such civil services by subcontracting outside the military, in the process realizing efficiency gains and cost savings compared with performing these functions within the military itself. If U.S. experience provides any indication, comparable functions might be performed by civil contractors at savings between 50 and 90 percent.[11]

- Utilization rates in the Korean defense industry have been extremely low in recent years.[12] To the extent that this industrial capacity is owned by the military, it may be efficient to consider selling it to the private sector and procuring from the new ownership the materiel and resupply that would otherwise be produced by these government-owned arsenals and military factories. The sale of such facilities might not only permit a more efficient scale of operation and utilization, but might also contribute to the conversion of underutilized capacity to civil uses, thereby providing a benefit to the economy as a whole. Although most Korean defense industry is already privately owned, this ownership is only nominal. Management and utilization are tightly controlled by the military, frequently resulting in low utilization rates, high operating costs, and restricted opportunities for conversion to higher yield civil production. Deregulation of privately owned defense industry could result in benefits corresponding to those that would ensue from selling government-owned defense industry to the private sector: namely, increased utilization of capacity, including production for civil use and lower unit costs for military production.

It appears that South Korea has a lucrative opportunity to benefit, in its military competition with the North, from drawing on the civil sector to a much greater extent than it has in the past. Further study and more systematic analysis should be devoted to this subject. Asymmetries between the North and the South in this dimension of the competition are so substantial that the prospective gains to South Korea from moving in this direction are likely to be large.

4. *Civil-military manpower complementarities.* The Korean armed forces discharge 40,000 men each year who are classified as scientific or

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[11]See Thomas Borcherding *et al., Comparing the Efficiency of Private and Public Production: The Evidence from Five Countries,* Institute for Empirical Research in Economics, University of Zurich, #46, 1982. The specific citation is taken from a study by the General Accounting Office in 1980 comparing the costs of ocean tanker repair and maintenance of the U.S. Navy with those of commercial tankers and oilers.

[12]Kyong Mann Jeon, *Defense Industrial Capabilities in Korea,* the Rand Graduate Institute, Ph.D. dissertation, forthcoming.

technical personnel.[13] There is thus a steady infusion of high-quality labor into the civilian labor force as a result of the added technical training and experience acquired in military service. The increased capabilities and productivity of the civil labor force can in turn be mobilized to enhance the technical and scientific capabilities within the military itself.

The benefits of training also flow the other way. Education, training, and technical experience in the civil sector provide the prospect of increased military effectiveness when personnel move from the civil sector into the military. For example, there is evidence that better educated recruits perform better in their military roles.[14] More highly educated South Korean personnel, including conscripts, are likely to be more effective than their less well educated counterparts in the North. However, this asymmetry between North and South should not be stretched too far. It is possible that less educated, yet more highly indoctrinated, North Korean soldiers might prove to be more aggressive in combat even if less educated or technically proficient than South Korean personnel.

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In sum, the larger, more dynamic, and more technically advanced South Korean economy provides the South with an impressive pool of assets that can be drawn on to enhance its capabilities for long-term military competition with the North. The asymmetry between the two sides with respect to this potential is striking. It provides the South with a lucrative source of both increased efficiency and increased capabilities.

To realize these potential advantages, several possible obstacles need to be recognized and surmounted: first, organizational inhibitions and inertia may be major impediments to a fuller utilization by the Korean armed forces of the capabilities of the civil sector. Military establishments generally prefer to have the capabilities they rely on located within their own establishments, and subject to their own control and command, rather than simply accessible on the outside. Consequently, moving in the direction of greater reliance on the civil sector and on civil assets for the military competition requires both reorientation and attitudinal flexibility—qualities that are much easier to describe than

[13]Labor, Education, and Research Institute, Korea University, *Economic Development and Military Technical Manpower of Korea*, Korea University Press, Seoul, 1976, p. 32.

[14]David J. Armor *et al.*, *Recruit Aptitudes and Army Job Performance: Setting Enlistment Standards for Infantrymen*, The Rand Corporation, R-2874-MRAL, September 1982.

they are to realize in practice, perhaps especially in the professional military services.

Second, for the military to be prepared to mobilize and utilize civilian assets in a crisis or conflict, extensive contingency plans must be made during peacetime. For example, requisitioning civilian vehicles during wartime or in a crisis can be an administrative nightmare if pursued on an *ad hoc* basis. However, if plans are made, and tested in advance, for particular owners of vehicle fleets to bring some of their vehicles to specified locations at specified times, the vehicles may be more quickly and reliably available to the military. Recognition of the problem in advance might permit its resolution by such incentives as offering reduced truck registration fees for those owners willing to agree to such an arrangement, and to participate in occasional peacetime exercises to assure that such plans could be effectively implemented in an emergency. Also, plans and exercises might be undertaken in peacetime to permit civilian construction crews to operate together as military units during a crisis. Contingency plans might provide for spare parts and repair manuals for certain types of military equipment to be stockpiled in civilian depots or other facilities during peacetime for eventual or possible use in an emergency.

Third, the existence of these highly valuable civilian assets in the South provides a potential prize for North Korean acquisition in the event of a conflict. Those civilian assets (such as vehicles or spare parts or other equipment) that might be of particular value to the North should perhaps be the object of special planning during peacetime to assure their protection in the event of hostilities, to prevent their loss to North Korean invading forces.

B. THE PARADOX OF RELATIVE MILITARY EXPENDITURES IN NORTH AND SOUTH KOREA

The paradox of relative military spending in South and North Korea can be stated plainly: South Korea apparently provides a larger volume of resources for defense purposes, yet has a smaller military capability than does the North. As Table 9 indicates, South Korea is spending considerably more on defense than is North Korea, and has since 1976. As Fig. 9 suggests, total resources allocated to defense for the period 1976–1983 were distinctly larger in South than in North Korea.

However, South Korea's total armed forces are smaller than those of the North, and its military capital stock is smaller than that of the North.

Table 9

COMPARISON OF NORTH AND SOUTH KOREAN
MILITARY EXPENDITURES, 1968–1983
(Millions of 1979 dollars)

Year	North Korea	South Korea	Ratio South/North
1968	1,398	1,195	0.85
1969	1,366	1,289	0.94
1970	1,655	1,358	0.82
1971	1,952	1,499	0.77
1972	2,266	1,537	0.68
1973	1,980	1,596	0.81
1974	2,341	1,827	0.78
1975	2,079	1,978	0.95
1976	2,236	2,409	1.08
1977	2,489	2,727	1.10
1978	2,521	3,184	1.26
1979	2,405	3,154	1.31
1980	2,665	3,431	1.25
1981	2,676	3,276	1.22
1982	2,523	3,399	1.35
1983	2,598	3,612	1.39
Cumulative			
1968-1983	35,150	37,381	1.06
1976-1983	20,113	25,102	1.25

SOURCE: Data for North Korea are from John Schank, memorandum, "Updated North Korean Military Personnel Costs," January 18, 1985, p. 3. Estimates for 1981 and 1982 are interpolations based on the totals in 1980 and 1983, an index of total defense spending in 1980 won, and the interpolation method developed by Kaplan and Moorsteen. The index is derived from total defense spending in current won in 1980–1983 given in *The Military Balance*, issues for 1980–1981 through 1984–1985, and an implicit deflator from U.S. Arms Control and Disarmament Agency, *World Military Expenditures and Arms Transfers 1972-1982*, April 1984, p. 33. For the interpolation formula, see Norman M. Kaplan and Richard H. Moorsteen, *Indexes of Soviet Industrial Output*, RM-2495, The Rand Corporation, 1960, Vol. I, pp. 61-65. Data for South Korea were obtained from KIDA. The original South Korean data were in won and have been converted to U.S. dollars. The procedures are explained in the notes to Table 11.

Three questions arise in this contrast between resources devoted to defense (where South Korea appears to be dominant) and the resulting military capabilities (where North Korea appears to be stronger): First, how real is the paradox (might it be apparent rather than real because of statistical errors in the estimates)? Second, if the paradox is real, how can it be explained? And third, what implications follow from these comparisons for the long-term military-economic competition between the South and the North?

1. *The statistical data.* Our estimates of defense expenditures for North and South Korea are subject to more than the usual reservations associated with comparing defense efforts in two countries in terms of the currency and prices of a third—in this case, U.S. dollars. The estimates for North Korea—in aggregate terms, and especially in terms of its breakdown among investment, operations, and personnel components—are especially prone to error. Reliable data on North Korean defense spending, as well as on the North's economy and society in general, are extremely elusive, and consequently even the best estimates should be treated with caution and regarded as preliminary.

In any event, our original estimates for the North were cross-checked using two independent methods: a building-block, order-of-battle methodology; and an aggregative methodology based on North Korean budget data and on estimates of end-use of North Korean GNP. Nevertheless, in the absence of information about the reliability of the underlying data, it is difficult to establish margins of error for the resulting estimates. In any event, the difference in the relative North-South spending levels—averaging about 25 percent over the past seven or eight years—is substantial; hence, the statistical errors would have to be sizable to affect the basic findings.

The principal components of the total defense estimates are manpower costs and military investment. Estimates of military personnel costs depend on the relative sizes of the two sides' forces and the per capita costs of military manpower. The difference between the sizes of the two sides' forces is small (over 600,000 for South Korea and over 700,000 for North Korea, during the period covered by the estimates).[15] Rand's estimates assume that the relative per capita costs of military personnel in the North is approximately one fourth that of the South Korean armed forces.

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[15] See, for example, the estimates of the International Institute for Strategic Studies, *The Military Balance,* for various years from 1968 to 1984, and the U.S. Arms Control and Disarmament Agency, *World Military Expenditures and Arms Transfers,* various years from 1971-1984.
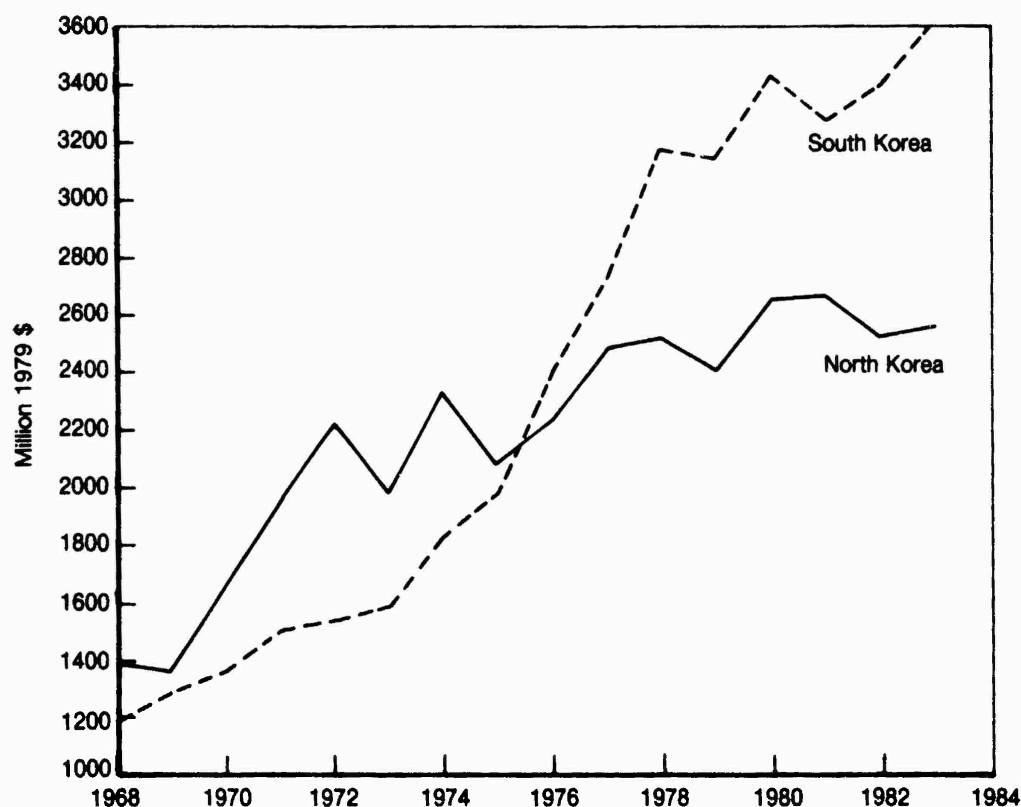
Fig. 9—Total military expenditures

Our preliminary estimates of military investment in North and South Korea are presented in Table 10. It should be noted that the Korean Institute for Defense Analyses does not concur in the estimates that are shown in Table 10. The methodological differences that may account for the differing estimates have been discussed by KIDA and Rand, and we hope to resolve them in the near future.

The capital stock figures are derived from crude estimates of capital stock in 1961 and from the subsequent annual military investment series, as follows: Military capital stock in 1961 (for both North and South Korea) is based on the reasonable assumption that the ratio of the military capital stock to military investment in that year is 6:1. For the period after 1961, military capital in each year is derived as the sum of the capital stock of the preceding year and military investment in the current year, minus depreciation, which is assumed to be 8

percent of the capital stock of the preceding year. The results are shown in Table 11.

In any case, the difference between the military capital estimates for North and South is so large and the preponderance of the North in this dimension has until recently been so great, that the finding is not likely to be changed by statistical refinements unless the margins of error are enormous. These considerations lead us to the conclusion that there is indeed a marked contrast between the resources allocated to defense in the two countries and their corresponding force levels and military capital stock. The question that arises is "why?"

2. *Understanding and explaining the paradox.* As Table 9 above indicates, North Korea's total spending on defense exceeded that of the South until the mid-1970s. Since there is generally a time lag between expenditures and the resulting military capabilities, perhaps part of the explanation for the difference between recent spending levels (which show the South's advantage) and military force estimates (which show the North's advantage) is attributable to this time lag. However, for the years since the late 1970s, annual and cumulative defense spending by the South is distinctly larger than in the North. Moreover, recent trends in relative defense spending suggest a widening of this gap over time. Consequently, if these trends continue, the South will be spending substantially more than the North in the years to come.

Disaggregating total military expenditures into their component parts, as shown in Table 10, gives a better picture of the paradox. As the table shows, the South has spent between two and a half and four times as much on personnel costs as the North. Comparing Table 10 with Table 9 suggests a major part of the explanation for the paradox. Until 1983, nearly all of the differences in total military spending between South and North since 1976 are attributable to the South's higher personnel costs—$600 million to $800 million annually. Table 10 also shows that the North spent more on procurement in the early and mid-1970s, while the South has been spending more than twice as much on procurement as the North in more recent years. The North has also spent considerably more on operations and maintenance than the South, presumably reflecting the North's larger military capital stock, as well as a higher rate of utilization of this stock in more active patrols and more frequent military exercises.

Finally, as Table 11 suggests, the rate of growth in the South's military capital stock has been much more rapid than that of the North, although starting from a smaller base. Projections based on these relative growth rates suggest that, in the next few years, the military capital stock of the South will catch up with and surpass that of the North.

Table 10

COMPARISON OF NORTH AND SOUTH KOREAN DEFENSE
SPENDING BY CATEGORIES, 1968–1983

(Millions of 1979 dollars)

Year	Procurement			Operations			Personnel		
	N	S	S/N	N	S	S/N	N	S	S/N
1968	418	52	.12	737	108	.15	243	1035	4.26
1969	300	85	.28	790	134	.17	276	1070	3.88
1970	549	72	.13	828	162	.20	278	1124	4.04
1971	796	98	.12	877	255	.29	280	1146	1.09
1972	1015	124	.12	962	325	.34	288	1088	3.78
1973	622	84	.14	1071	336	.31	286	1176	4.11
1974	948	79	.08	1248	502	.40	297	1246	4.20
1975	501	303	.60	1250	462	.37	328	1213	3.70
1976	610	697	1.14	1286	510	.40	339	1202	3.55
1977	728	890	1.22	1329	651	.49	378	1186	3.14
1978	732	1152	1.57	1406	826	.59	383	1206	3.15
1979	488	997	2.04	1470	934	.64	446	1223	2.74
1980	654	1009	1.54	1502	1063	.71	509	1269	2.49
1981	547	928	1.70	1558	1070	.69	566	1278	2.26
1982	338	1062	3.14	1616	1113	.69	568	1224	2.15
1983	359	1117	3.11	1677	1218	.73	568	1277	2.25

SOURCE: Data for North Korea in 1968–1980 are from Schank, 1985. Those for 1981–1983 have been separately derived for the three components as follows: (1) Defense expenditures on *military personnel* are based on linear regression of these expenditures in 1975–1980 (from Schank) on the size of armed forces in 1975–1893 from the International Institute for Strategic Studies, *The Military Balance*, issues for 1975–1976 through 1983–1984. The latter series for 1975–1980 differs only slightly from that of previous estimates, so that the R-square is fairly high, 0.9206); (2) defense expenditures on *operations* are based on the assumption of a linear time trend for the period 1975–1983. Again, the R-square is quite high, 0.9847; (3) defense expenditures on *procurement* are derived as residuals by deducting expenditures on personnel and operations from total defense expenditures given in Table 9. Estimates for South Korea for the period 1968–1982 are based on defense expenditures in current won and in 1975 won for this period. A series in 1979 won is derived from these figures and then converted to 1979 U.S. dollars using the 1979 exchange rate of 484 won per U.S. dollar. (See *International Financial Statistics*, January 1984, p. 238.) South Korea's defense expenditures on each of the three categories in 1983 are assumed to have increased over 1982 in proportion to the spending estimates for military Option I in the SMOKE simulations summarized in Sec. V above.

Table 11

MILITARY CAPITAL STOCK, NORTH AND SOUTH KOREA
(Millions of 1979 dollars)

Year	North	South	S/N
1968	1,998	198	0.10
1969	2,138	249	0.12
1970	2,138	328	0.13
1971	3,111	382	0.12
1972	3,877	452	0.12
1973	4,189	543	0.13
1974	4,802	578	0.12
1975	4,919	653	0.13
1976	5,135	904	0.18
1977	5,452	1,481	0.27
1978	5,748	2,129	0.37
1979	5,776	2,885	0.50
1980	5,968	3,455	0.58
1981	6,038	4,125	0.68
1982	5,893	4,703	0.80
1983	5,780	5,443	0.94

SOURCE: Estimates of military investment for North and South Korea in 1961–1968 are derived from that for 1968 given in Table 10 and an index of defense expenditures in 1961–1968 taken from U.S. Arms Control and Disarmament Agency, *World Military Expenditures 1971*, 1972, p. 19. For estimates of military investment in 1968–1983, see Table 10.

Estimates for South Korea for the period 1968–1982 are based on estimates made in 1975 won by Donald Henry, forthcoming, together with an implicit price deflator for South Korea military investment provided by KIDA to derive a series in 1979 won; and an exchange rate of 484 won per dollar to convert the totals to those in 1979 U.S. dollars. The estimate for 1983 is derived by allowing 8 percent depreciation of the capital stock in 1982 and adding the military investment in 1983 from Table 10.

These comparisons help to clarify the original paradox. Higher military spending by the South relates mainly to higher personnel costs and higher spending on military procurement in recent years. The smaller force size and lesser military strength of the South compared with the North derives from the larger manpower totals in the North Korean armed forces, and to the accumulation of a larger North Korean total military capital stock resulting from the 1970s' buildup phase. Looking ahead, it would appear that the South's military spending is likely to remain larger than that of the North, as its economic growth continues to outpace that of the North by a

substantial margin. The South's larger procurement expenditures will tend to narrow or eliminate the gap between the two sides' military capital stock (in the absence of substantial unexpected military aid from the Soviet Union or China), but the difference between the manpower totals of the two sides is likely to remain.

3. *Implications for South-North long-term competition.* The previous analysis only scratches the surface of issues that warrant more thorough investigation. Further investigation should include consideration of the following issues:

- The dollar costing of Soviet-type weapons systems in the North Korean inventory confronts the usual and serious problems of estimation involved in estimating Soviet military expenditures in dollars. At the same time, the dollar cost of weapons systems in the South are higher because these systems embody more costly U.S. technology, and so presumably (although not necessarily) represent greater military effectiveness. There is thus a question of whether the higher cost of U.S. weapons systems, which raise the South Korean procurement budget, represent equivalent military effectiveness, or simply higher cost for given effectiveness, compared with procurement expenditures in the North.

- The South organizes its forces on the basis of a defensive strategy emphasizing greater staying power and hence larger service support units in the form of reconnaissance, transportation, medical, engineering, and related functions. Part of the increased expenditures in the South may reflect a higher "tail-to-teeth" ratio than in the North, resulting in relatively less striking power associated with the South Korean forces.

- In the North Korean system the military pervades the entire economy and society. It is therefore especially difficult to estimate the true size of the military burden. For example, factory workers in North Korea engage in regular military training drills and exercises. Industrial plants are frequently built to military specifications (including defense hardening, underground construction, preparations for shifting from nonmilitary to military production, and so on). On the other hand, military forces also play civil roles—for example, in contributing to agricultural harvesting and to the engineering and building of industrial plants. Measuring and netting out these offsetting tendencies is a difficult task with an elusive bottom line. Nevertheless, it is very likely that, if the true military effort of the North Korean system were to be fully and completely

costed, we would have a somewhat larger estimate of equivalent military spending in the North than that which results from the methodology used in the estimates shown in Tables 9, 10, and 11.

Whatever the explanation for the larger defense expenditures in South Korea than in the North in recent years, the key remaining question is whether these larger costs signify relatively greater military effectiveness for the South than has been allowed for in the accepted estimates? Effectiveness depends also on qualitative factors such as morale, leadership, education, and training that are not included in the foregoing comparisons of military spending.

Here again the balance sheet is inconclusive. On the one hand, the higher cost per military man in the South should reflect, at least to some extent, the "higher quality" of South Korean military personnel: the higher military pay may be necessary to attract and keep more qualified men in the services. On the other hand, the more intense indocrination, austerity, and regimentation of military personnel in the North may produce military manpower with an intensified capability and proclivity for effective combat.

It is well to remember that some of these qualitative factors which we have not been able to measure may dominate those that we have. Nevertheless, the result that seems to emerge from this examination of the paradox of relative military spending and relative military effectiveness is this: As the economic and technological base of South Korea continues to expand as it has in the past few years, and as the substantial gap between the two sides widens even further, South Korea's capabilities for the long-term military competition will dominate those of the North. The paradox that has been manifest in the past will, at that point, be resolved in favor of South Korea.

C. AGRICULTURAL SUBSIDIES

Although agricultural subsidies seem at first glance to be remote from the subject of economic and technological capabilities for long-term military competition, the connection between them is real and potentially important. Agricultural subsidies absorb an appreciable part of South Korea's fiscal resources, and represent a significant efficiency loss to the economy in that resources are diverted to less productive uses. Consequently, removal or reduction of the subsidies would, in principle, free resources for military competition and, again in principle, would ease the burden of South Korea's military spending on the national economy.

This is not to deny the important political, social, and other arguments in support of agricultural subsidies, as discussed at greater length below. However, our principal aim here is simply to measure and highlight the economic consequences of the subsidies, and consider the effects that might ensue for the South-North competition if the subsidies could be reduced.

Two concepts of agricultural subsidies can be distinguished: (1) financial subsidies resulting from price differentials between the government procurement price and the selling price of grain (mainly rice and barley) and chemical fertilizer, and (2) economic subsidies, defined as the efficiency loss or opportunity cost to the economy as a whole, because of the differential between the domestic and imported prices of grain or fertilizer.

1. *Financial subsidies.* Table 12 shows the total financial subsidies, and their size relative to defense spending and to GDP, all in current prices. Table 13 compares the ratio of financial subsidies to total government revenues in Korea with the corresponding ratio for India, Pakistan, and Sri Lanka. Table 14 shows the changing size of subsidies per ton of rice output, for direct grain subsidies, and for chemical fertilizer subsidies.

Table 12

FARM SUBSIDIES, 1975–1982

Year	Financial Subsidies (billion won)	Subsidy as % of Defense	Subsidy as % of GDP
1975	94	20.1	1.0
1976	50	6.5	0.4
1978	285	19.8	1.2
1979	296	18.5	1.0
1980	320	14.2	0.9
1981	505	17.8	1.1
1982	(248)	—	(0.5)

SOURCE: Financial subsidies for 1978–1982 are provided by John Bennett of the Korean Institute, and those for 1975–1976 are from United Nations, *Economic and Social Survey of Asia and the Pacific, 1982*, Bangkok, 1983, p. 174. For defense spending, see International Monetary Fund, *Government Financial Statistics Yearbook 1983*, 1983, p. 437. Data on GDP are taken from *International Financial Statistics*, February 1984, p. 285.

Table 13

FARM SUBSIDIES AS PERCENTAGES OF GOVERNMENT
REVENUES, SELECTED COUNTRIES, 1976–1981

Year	Korea	India	Pakistan	Sri Lanka
1976	2.2	4.4	8	16
1977	N/A	3.7	5	21
1978	6.9	3.7	6	18
1979	5.4	4.3	9	22
1980	4.7	3.6	7	14
1981	5.9	3.5	4	11

SOURCE: Data for Korea are based on totals in Table 12
and International Monetary Fund, *Government Financial
Statistics Yearbook 1983*, 1983, p. 435. Data for other countries
are from United Nations, 1983.

Table 14

OUTPUT OF RICE AND FARM SUBSIDIES, 1976–1982

Year	Farm Subsidies $Grain(S_1)$ (billion won)	$Fertilizer(S_2)$	Output of rice (O) (1,000 tons)	Ratio S_1/O (won/ton)	S_2/O
1976	50	N/A	7,243	6,903	N/A
1978	247	38	8,532	28,950	4,454
1979	231	65	7,881	29,311	8,248
1980	155	165	5,311	29,185	31,068
1981	325	180	7,149	45,461	25,178
1982	248	N/A	7,308	33,935	N/A

SOURCE: Farm subsidies are provided by John Bennett.
Output data are from United Nations, *Statistical Yearbook
1981*, New York, 1982, p. 495; United Nations, *1982 FAO Pro-
duction Yearbook*, Vol. 36, Rome, 1983, p. 111.

Several conclusions can be inferred from these tables:

- Financial subsidies have amounted to about 1 percent of South
  Korea's GDP in recent years. In fact, it has remained at this
  level since 1978, indicating that financial subsidies were
  increasing at more or less the same rate as GDP in current
  prices over the same period. Compared with defense expendi-
  tures, financial subsidies ranged from 6 to 20 percent of defense
  spending from 1975 to 1981. In most of these years, this ratio
  was about 18 percent. Thus, hypothetically, a shift of subsidies

to defense could increase the defense budget by about 18 percent.

- Financial subsidies as a percentage of total government revenue in Korea are not particularly large compared with other developing countries, such as India, Pakistan, and Sri Lanka, where this policy instrument is also extensively used (see Table 14). They are somewhat higher than India, roughly the same as Pakistan, and far below those of Sri Lanka.

- There has not been any discernible rising trend in rice production since 1976. Output remained at the level of 7 to 8.5 million tons, except in 1980 when the harvest was poor. Yet grain subsidies increased, so that on a per-ton basis, subsidies rose from 7,000 won in 1976 to 34,000 won in 1981. It appears that the subsidies had little effect as a stimulant to increase output. The data also suggest that, if rice output should increase, it would have a multiplicative effect on the burden of subsidies in the government budget, unless offset by price changes.

2. *Economic subsidies.* Economic subsidies represent an efficiency loss to the economy because of distortion of the price system. The loss can be approximately measured by the price differential between what the economy actually pays (for grain or chemical fertilizer) and what the economy would have paid if it chose instead to purchase from the lowest cost alternative source. In the present instance, this efficiency loss is the difference between the domestic consumer prices of rice and barley and their corresponding import prices. Similarly, the efficiency loss from chemical fertilizer subsidies is the difference between the price at which the government sells fertilizer to farmers and the price which farmers would have to pay if they instead bought from a competitive market. The total efficiency loss would then be the product of the price differential and the quantity of rice or chemical fertilizer involved in the respective transactions.

Our preliminary calculations (which are explained in App. B) indicate that economic subsidies for rice production in South Korea are substantial: almost $2.4 billion in 1981, or about 3 percent of Korea's GNP. There are some reasons for thinking this estimate may be too high, because of the probable overvaluation of the won used in the calculations. However, there are probably at least offsetting reasons why the $2.4 billion figure may be too low an estimate of the total economic loss from agricultural subsidies, because this figure is confined to rice subsidies alone; allowing for the subsidies for barley and chemical fer-

tilizer would thus add to this estimate.[16] In sum, the potential efficiency gains to the South Korean economy as a whole by removal of the subsidies could amount to about half the size of the current Korean defense budget.

3. *Costs and benefits of subsidies.* In general, several arguments have been made in favor of subsidies: partial self-sufficiency in food supply for security reasons; preserving the rural way of life in Korea as a desirable goal both in its own right and as a contributor to social security; and, finally, as a safety valve against the abrupt rise in urban unemployment that might ensue from movement of rural population to urban areas. Whatever the rationale, the economic effects of subsidies can be far-reaching.

First, subsidies are a negative tax, and clearly have direct effects on redistribution of income. Farmers are better-off, at the expense of consumers and taxpayers. Whether this redistribution of income is desirable is a political and social decision. However, it remains an economic question whether subsidization is the optimal way to transfer income, since other effects must also be considered.

Second, closely related to the redistributive effect is the possible effect on domestic savings. As a result of the subsidies, government savings are reduced by the same amount. Unless the recipients of the subsidies save the entire amount, there will be a net reduction in domestic savings. More generally, if we look at the government simply as an agent, transferring resources from consumers to farmers, domestic savings will increase, remain unchanged, or decline, depending on whether the marginal propensity to save among the farmers would be higher, the same, or lower than that of consumers.

Third, subsidies may well be inflationary. The deficit on the government grain account will have to be financed by taxes or overdrafts on the central bank. The latter was the case in the 1970s.[17] When that happens, the overdraft adds to the rise in money supply.

Fourth, there may be long-term effects. As noted by Eberstadt, subsidies tend to freeze land-use patterns, and force up the price of farm land, frustrate the consolidation of small farms into larger, low-cost units, and raise the cost of nonagricultural real estate.[18] Offsetting these adverse effects are the possible savings of foreign exchange that would have to be used to import grain in the next decade as a result of possible scenario changes.

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[16]See App. B.

[17]Edward S. Mason *et al., The Economic and Social Modernization of the Republic of Korea,* Harvard University Press, Cambridge, 1980, p. 234.

[18]Nick Eberstadt, "Bureaucratic Blight Hits Agriculture in Three Nations," *Wall Street Journal,* September 19, 1983, p. 29.

In sum, government policies on agricultural subsidies are relevant to an evaluation of South Korea's capabilities for long-term military competition. The magnitude of the subsidies, and the potential they represent for shifting both fiscal resources and total resources toward military purposes, warrant further consideration by Korean policymakers.

VII. CONCLUSIONS

The preceding sections suggest several conclusions regarding the relative capabilities of South and North Korea for the long-term competition between them:

South Korea's economic and technological advantages over North Korea are substantial. The economy of South Korea is currently about four and a half times as large as that of the North. While recognizing the difficulties and hazards of international income comparisons, South Korea's GNP in 1984 amounted to over $80 billion, whereas we have estimated that of North Korea, according to the forecasts summarized in Sec. V, to be between $16 and $20 billion. Consequently, military spending in the South of 6 to 7 percent of the South Korean GNP is equivalent in real terms to about 27 to 31 percent of North Korea's GNP—a share that is probably somewhat above what North Korea actually devotes to direct military use. This rough comparison is borne out by the discussion in Sec. VI on the paradox of relative military spending levels in the North and South.

Technologically, a similar gap prevails between the South and the North. South Korea possesses world-class capabilities in engineering, construction, shipping, and shipbuilding, as reflected by its large annual foreign exchange earnings (over $8 billion in 1984) in these fields, and its strong international competitive position in them. Its international position in higher quality consumer goods markets is also strong and growing. In higher technology fields, South Korea's increased capabilities are reflected by the accelerated growth in production and exports of its electronic industry, as well as by several recent joint production, investment, and distribution ventures of Korean firms with General Motors, IBM, AT&T, Texas Instruments, Chrysler, Fairchild Semiconductor, and other high technology American firms. In contrast, North Korea's international technological competitiveness is largely restricted to the production of weapons embodying Soviet technology of the early 1960s. (Although the technology is antiquated, North Korea's weapons exports have been quite adequate in the contingencies where they have appeared in Africa, the Mideast, and Central America.)

The economic preponderance of South Korea over North Korea is growing rapidly. South Korea's relative economic and technological advantages over the North are growing markedly. South Korea's annual rate of economic growth is between 7 and 8 percent,

compared with 2.5 to 3 percent for North Korea. Although the simulations summarized in Sec. V forecast a slightly declining rate of real growth for South Korea in the next decade (varying between 5.6 percent and 6 percent per annum for the several scenarios covered), this still represents a growth rate more than twice that of the forecasts for North Korea. On this basis, the South Korean economy by the mid-1990s will be more than six times as large as that of North Korea. Military spending of 6 to 7 percent in South Korea would then be equivalent to a defense spending share in North Korean GNP of between 36 and 42 percent.

In some re ects, the comparison between South Korea and North Korea has similar attributes to that between the United States and the Soviet Union. For example, both the United States and South Korea have larger, stronger, more dynamic, more rapidly expanding, and more technologically sophisticated economies, whereas the respective advantages of the Soviet Union and North Korea in their own military endeavors lie in the more intense national mobilization and higher priority they accord to military demands. Indeed, the pervasive militarization of North Korea's socio-economic system is even more extreme than that of the Soviet Union.

South Korea's economic and technological development should enable it to realize significant advantages in its long-term military competition with the North. Drawing on its major economic and technological advantages, South Korea can greatly enhance its military capabilities relative to those of the North. As described in Sec. VI, South Korea has numerous unexploited opportunities for drawing on its powerful civilian economic base: to better its general industrial mobilization capability; to augment its order of battle by contingency plans for mobilizing civilian vehicles, aircraft, merchant shipping, maintenance facilities, and engineering and construction capabilities; and by realizing significant peacetime cost savings through greater use of subcontracting for military support functions in the civil sector.

Section IV describes various ways in which South Korea can improve its direct military capabilities over the next eight to ten years; for example, additions to South Korean airborne and amphibious forces could constitute a credible counteroffensive capability against the North (as suggested in one of the military options described in Sec. IV). Hitherto, North Korea has been in the fortunate position of being able to deploy most of its forces for attack, whereas South Korean forces have been configured and deployed for defense. North Korean territory above the DMZ has thus been relatively unthreatened by a combat-ready South Korean force capable of occupying it.

Enhancement of South Korea's counter-offensive capabilities would add to deterrence and stability between the two sides by obliging North Korea to retain some of its forces for protecting Pyongyang, thereby diminishing its concentrated threat at the 38th parallel.

Expansion of South Korea's military capabilities along these lines would involve a nonnegligible rise in defense spending of 2 or 3 percent of GNP during some years of the next decade, as indicated in Sec. V. However, this increase in resource mobilization is well within the economic and technological capabilities of the Republic. *The constraints on South Korea's seeking to strengthen its military capabilities by drawing more resources from the civil economy are mainly political; the constraints that North Korea faces in attempting still further to enhance its military position are predominantly economic and technological.*

Of course, a decision by the South to move in this direction would require careful consideration. If such a move were abrupt, it could be provocative. Also, it could trigger stepped-up support for the North from the Soviet Union to provide a countervailing expansion of North Korean forces. If enhancement and expansion of South Korean capabilities were spread over an 8–10 year period, as envisaged in Secs. IV and V, the probability of these countervailing reactions would be lessened.

A corollary of the foregoing discussion is that South Korea can plausibly aspire to an increasing degree of military self-reliance. For example, the U.S. 2nd Division in Korea derives its principal value as a symbol rather than as an irreplaceable combat force. To an increasing extent, its direct military contribution could be provided from an upgrading of South Korea's own corresponding military capabilities, with responsibility for advanced weapons assumed by a modest expansion of U.S. tactical Air Forces based in Korea. To be sure, the symbolic importance and deterrent effect of a major U.S. presence in South Korea can hardly be overestimated; the situation is analogous to that of U.S. forces in West Germany. Nevertheless, if the United States and the Republic of Korea were disposed to do so, there is no inherent reason why the two allies could not maintain or even raise that symbol at a lower level of U.S. ground forces in Korea—for example, by a further expansion of U.S. air units, as well as by a firmer reiteration of U.S. declaratory policy. Responsibility for advanced weapons could be protected by the expanded air units, as well as by the remaining U.S. ground forces. That such measures would have to be worked out carefully, deftly, jointly, and cooperatively is both obvious and crucial.

The role of foreign military credits and sales (FMS) in supporting South Korea's force improvements along the

alternative lines, and with the alternative economic conse-
quences, described in Secs. III and IV above, as well as its role
in contributing to increased military self-reliance in South
Korea, is probably more important than suggested by the simu-
lation results summarized in Sec. V. The formal structure of the
SMOKE model tends to attenuate the evident influence of FMS, due
to the high level of aggregation which the model embodies. SMOKE is
so aggregative that the effects of FMS are swallowed up by the larger
economic aggregates dealt with in the model: specifically, by the size
of the Korean capital stock which affects total production; by the total
volume of capital imports; and by the "additionality" assumption,
according to which 40 percent of FMS simply acts as a substitute for
other capital imports.

Quite apart from this characteristic of the model, South Korea will
have to alter both the amounts and types of its capital inflows during
the next decade if it is to reduce its present $43 billion external debt.
To accomplish this, the South will be obliged to export capital if it is
to amortize the principal of its present debt. Such capital inflows as do
occur should preferably take the form of equity investments and joint
ventures, to avoid adding to the already large debt servicing require-
ments associated with South Korea's previous international borrowing.

The question posed at the outset—"on whose side is
time?"—can be answered directly: South Korea's economic,
technological, and military capabilities can be expected to grow
substantially relative to those of North Korea during the next
decade; barring the unlikely and the unexpected, time is
decidedly on South Korea's side. Several qualifications should be
added to this conclusion:

- First, the conclusion is subject to the political constraints and
  uncertainties described in Sec. II, notably those relating to a
  successful outcome to the constitutionally provided transfer of
  executive leadership in South Korea in 1988.
- Second, uncertainties also arise from factors that have either
  been omitted from our models and analysis, or have been
  treated as exogenous and unexplained variables. These factors
  include, especially, possible changes in the terms or volume of
  trade realized by South Korea (e.g., with respect to oil prices, or
  to growth of protectionism for Korea's exports in the interna-
  tional markets), unforeseen changes in labor supply, and
  changes in technological progress and productivity, due to one
  or more of the considerations mentioned in Sec. V. However, it
  is worth noting that these factors are no less likely to move in

directions congenial to South Korea's economic and technological strength than ones that would be inimical to it. It is worth recalling that the combined effects of these exogenous variables can alter Korea's economic growth by a factor of two or three: if the factors combine in beneficent ways, South Korea's GNP would grow at an annual rate of well over 8 percent; if combinations are adverse, South Korea's growth could well be as low as 3 percent per year.

- Finally, we have left unanswered the question of how this predicted change in the South-North balance, in South Korea's increasing favor, will affect the reactions and behavior of the North. On the one hand, the changing balance and its anticipation may lead the North toward more conciliatory behavior; there have been some modest signs in this direction over the past year. On the other hand, it is not less likely that the anticipated change in the balance could lead North Korea toward more aggressive efforts to interdict the growing disparity between the two sides. This, in turn, may be affected by restraint or prodding from the Soviet Union or China—perhaps more restraint by the PRC than by the Soviet Union.

Appendix A

A SMALL MODEL OF THE KOREAN ECONOMY (SMOKE)[1]

Donald P. Henry

This appendix gives detailed information about the equations that appear in SMOKE.

The variables used in SMOKE are:

Civilian consumption	CC
Civilian investment	I
Defense spending	DEF
Defense labor expenditure	GML
Defense investment expenditure	GMI
Defense O&M expenditure	GMK
Capital inflows (excluding FMS)	CAPXM
Foreign military credits	FMS
Gross national product	Y
Civilian sector income	YC
Civilian labor	LC
Military labor	LM
Total labor supply	LT
Time	T
Wage rate	W
Military capital stock	KM
Civilian capital stock	KC

The structure of SMOKE is described below. Equations appear in the order in which they are solved rather than by sector or type of equation. This organization makes the flow of the model easier to understand.

The t, R-squared, and Durbin-Watson statistics are given for the estimated equations. Not all the estimated equations appear in the model in the format in which they are estimated. The production function, for instance, is estimated in logarithmic form, but appears in the model in standard form. When the estimation form differs from the form in the model, the t and Durbin-Watson statistics are derived

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[1]See Donald P. Henry, *SMOKE: A Small Model of the Korean Economy*, The Rand Corporation, N-2381-NA, forthcoming.

from the estimation. The R-squared statistics, on the other hand, are calculated from the form used in the model.

EQUATION 1: The Civilian Capital Stock (KC)

$KC_t = (1.0 - 0.08) \, KC_{t-1} + I_{t-1}$
Construction—not estimated
Dependent variable: KC
Lagged endogenous variables: KC_{t-1}, I_{t-1}
Parameter: $depr$ (not estimated)
$KC_t = (1.0 - depr) \, KC_{t-1} + I_{t-1}$

The parameter KC is the civilian capital stock in the previous year increased by investment in the previous year and decreased by depreciation. This relationship is not estimated. A depreciation rate of 8 percent is discussed in Henry (forthcoming).

EQUATION 2: The Military Capital Stock (KM)

$KM_t = (1.0 - 0.08) \, KM_{t-1} + GMI_{t-1}$
Construction—not estimated
Dependent variable: KM
Lagged endogenous variables: KM_{t-1}, GMI_{t-1}
      (defense investment in $t - 1$)
Parameter: $depr$ (not estimated)
$KM_t = (1.0 - depr) \, KM_{t-1} + GMI_{t-1}$

The military capital stock is calculated in the same manner as the civilian capital stock except that military rather than civilian investment is used. The choice of the depreciation rate is given in Henry (forthcoming).

EQUATION 3: Total Employment (LT)

$LT_t = 5695.4 \, EXP(0.0336646T)$
    (520.0)   (43.1)
R-squared: 0.986   D.W.: 0.53
Dependent variable: LT
Exogenous variable: T
Parameters: $L0, g$
$LT_t = L0 \, EXP(g \, T)$

Total employment is generated by an exponential growth trend. The equation is estimated in logarithmic form. The 0.0336 represents the employment growth rate estimated from data of the past two decades. In the simulations described in Sec. V, this parameter has been varied between 0.012 and 0.032, as explained there. The high Durbin-Watson reflects business cycles in the Korean economy.

EQUATION 4: Civilian Employment (LC)

$LC_t = LT_t - LM_t$
Identity—not estimated
Dependent variable: LC
Endogenous variable: LT (Total Labor Supply)
Exogenous variable: LM (Military Labor)

Civilian employment is total employment less military employment. This is an identity and is not estimated.

EQUATION 5: Civilian Production (YC)

$$YC_t = EXP(-0.752004 + 0.664034\ LOG(LC_t + (1.0$$
$$\qquad\qquad (-18.6) \qquad (72.3)$$
$$-0.664034)\ LOG(KC_t) + -0.0334588\ LOG(LC_t/KC_t)2$$
$$\quad (72.3) \qquad\qquad\qquad (-3.8)$$
$$+ 0.0215797\ T)$$
$$\qquad (12.2)$$

R-squared: 0.984   D.W.: 0.8848
Dependent variable: YC
Endogenous variables: LC, KC
Exogenous variable: T
Parameters: $p0, p1, p2, p3$
$$YC_t = EXP(p0 + p1\ LOG(LC_t) + (1.0 - p1)\ LOG(KC_t)$$
$$+ p2\ LOG(LC_t/KC_t)2 + p3\ T)$$

Civilian production is determined by the civilian capital stock, civilian employment, and a time trend representing technological progress. These three factors are combined in a trans-log production function which is constrained to have constant returns to scale. A trans-log production function is more general than a Cobb-Douglas production function. Factor shares in a Cobb-Douglas function remain the same no matter how much factor ratios change. A trans-log function allows the factor shares to change as the capital-labor ratio changes. A Cobb-Douglas function is, in fact, a special case of a trans-log function. This equation is estimated jointly with the wage rate (which is transformed to the labor share of output). The production equation is estimated in logarithmic form:

$$LOG(YC_t) = p0 + p1\ LOG(LC_t) + (1.0 - p1)\ LOG(KC_t)$$

$$+ p2\ LOG(LC_t/KC_t)2 + p3\ T$$

$$LSH_t = (W_t / wrc) LC_t / YC$$

$$= p1 + 2.0 \, p2 \, LOG(LC/KC)$$

The two equations share two parameters: $p1$ and $p2$. The labor share of output (LSH) is used because, in this form, $p1$ and $p2$ both appear in the two equations, and the wage equation has a simple formula in terms of LC and KC. If the wage rate itself is used, either YC appears in the equation, with resulting estimation difficulties, or a very complex function of LC, KC, and T must be used. Joint estimation should improve the parameter estimates in both equations. The wage series is only an index number, so the constant wrc is used to scale the wage index to wage level.

EQUATION 6: *The Civilian Wage Rate (W)*

$$W_t = 210.712 \, (0.664034$$
$$(71.6) \quad (72.3)$$
$$+ 2.0 - 0.0334588 \, LOG(LC_t / KC_t)) \, YC_t / LC_t$$
$$(-3.8)$$

R-squared: 0.966 D.W.: 0.53
Dependent variable: W
Endogenous variables: LC, KC, GML
      (defense labor expenditure)
Parameters: $wrc, p1, p2$
$W_t = wrc \, (p1 + 2.0 \, p2 \, LOG(LC_t / KC_t)) \, YC_t / LC_t$

See the discussion under Eq. (5) on civilian production.

EQUATION 7: *Military Labor Costs (GML)*

$$GML_t = 0.00325433 \, W_t \, LM_t$$
$$(53.9)$$

R-squared: 0.947 D.W.: 1.11
Dependent variable: GML
Endogenous variable: W
Exogenous variable: LM
Parameter: mwm
$GML_t = mwm \, W_t \, LM_t$

Military labor costs are the military wage times military manpower levels. The military wage is a fraction of the civilian wage, expressed as an index. The mwm is estimated through ordinary least squares.

EQUATION 8: *Gross National Product (Y)*

$$Y_t = YC_t + GML_t$$
Identity—not estimated

Dependent variable: Y
Endogenous variables: YC, GML

Gross national product is the sum of civilian and military incomes. It is an identity and is not estimated.

EQUATION 9: Military O&M Costs (GMK)

$$GMK_t = -60.3396 + 0.0985828\ KM_t + 0.737958\ GML_t$$
$$\quad\quad\quad (-2.5) \quad\quad\quad (3.4) \quad\quad\quad\quad (4.6)$$

R-squared: 0.956 D.W.: 1.06
Dependent variable: GMK
Endogenous variable: KM, GML
Parameters: $m0, mkm, mlm$
$$GMK_t = m0 + mkm\ KM_t + mlm\ GML_t$$

Military O&M is a linear function of the military capital stock in place and military personnel expenditures.

EQUATION 10: Defense Spending (DEF)

$$DEF_t = GML_t + GMK_t + GMI_t$$

Identity—not estimated
Dependent variable: DEF
Endogenous variables: GML, GMK
Exogenous variable: GMI

Defense spending is the sum of military labor costs, military O&M costs, and military investment. It is an identity and is not estimated.

EQUATION 11: Civilian Investment (I)

$$I_t = (Y_t + CAPXM_t + FMS_t - DEF_t)\ 1.13653\ ((-0.02485$$
$$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad (2.8)$$
$$\quad + 2.0(0.0334588)\ LOG(LC_t / KC_t))\ (Y_t - GML_t) / KC_t$$
$$\quad - (-0.293268 + 1.14621\ EXP(-0.0609347\ T)))$$
$$\quad\quad (-2.6) \quad\quad\quad (4.9) \quad\quad\quad\quad (-2.3)$$

R-squared: 0.977 D.W.: 1.08
Dependent variable: I
Endogenous variables: Y, DEF, LC, KC
Exogenous variables: $CAPXM$ (capital inflows, excluding foreign military credits), FMS (foreign military credits)
Parameters: $i0, i1, i2, i3$

$$I = (Y_t + CAPXM_t + FMS_t - DEF_t)\ i0((P1$$
$$\quad + 2.0\ P2\ LOG(LC_t / KC_t))\ YC_t / KC_t$$
$$\quad - (i1 + i2\ EXP(-i3T)))$$

The resources available for final spending in the Korean economy are national income augmented by capital inflows. In SMOKE, defense spending is considered a prior claim on the economy, so the resources available for consumption and investment are national income augmented by capital inflows and reduced by defense spending. This is the first term of the investment equation,

$$(Y_t + CAPXM_t + FMS_t - DEF_t)$$

The share of this total that goes to investment rather than consumption is represented by the next two terms,

$$i0 ((P1 + 2.0 \ P2 \ LOG(LC_t / KC_t)) \ YC_t / KC_t - (i1 + i2 \ EXP(-i3 \ T)))$$

This is a complicated expression and needs to be picked apart carefully. Underlying the actual expression is a simpler idea: the investment share of available resources is a linear function of the difference between the marginal product of capital and the shadow cost of capital in Korea, or

$$\text{Investment share} = a + i0 \ (MPK - r)$$

where MPK is the marginal product of capital and r is the real interest rate. The idea here is that the investment share will increase if the marginal product of capital rises relative to the interest rate and will fall if the marginal product of capital falls relative to the interest rate. There will still be some investment even if the marginal product of capital is equal to the interest rate: replacement investment. The marginal product of capital in SMOKE is,

$$(P1 + 2.0 \ P2 \ LOG(LC_t / KC_t)) \ YC_t / KC_t$$

The shadow cost of capital is an equally complicated expression. The underlying concept is that the Korean economy will eventually approach a constant real interest rate or shadow cost of capital. Because of its ambitious investment program, the need to borrow funds abroad, and the risks associated with international loans, Korea is paying a premium over this long-term rate, a premium that will fall through time. This "interest rate" is thus expressed as a constant plus an exponential decay trend:

$$r = b + i2 \ EXP(-i3 + T)$$

where T is time. Unfortunately, when this expression is plugged into the investment share equation,

$$\text{Investment share} = a + i0 \; (MPK - r) = a + i0$$

$$(MPK - (b + i2 \; EXP(-i3 \; T)))$$

the a and the b parameters cannot be estimated individually. The share is rewritten as

$$\text{Investment share} = i0 \; (MPK - (i1 + i2 \; EXP(-i3 \; T)))$$

where $i1$ is b minus $a / i0$. If the actual MPK expression is used, and if the share is multiplied by the available resources, the complete investment equation used in SMOKE emerges.

EQUATION 12: Civilian Consumption (CC)

$$CC_t = Y_t + CAPXM_t + FMS_t - DEF_t - I_t$$

Identity—not estimated
Dependent variable: CC
Endogenous variables: Y, DEF, I
Exogenous variables: $CAPXM, DEF$

Civilian consumption is the residual of national income augmented by capital inflows and reduced by defense spending and investment. It is an identity and is not estimated.

Appendix B

ESTIMATING AGRICULTURAL SUBSIDIES IN SOUTH KOREA

K. C. Yeh

To clarify the estimation problem, it is useful to note that three parties are involved in South Korea's agricultural subsidies: the government, the farmers, and the consumers. Accordingly, there are three sets of prices: government procurement prices, government selling prices (which for convenience are assumed to be the same as the consumer prices),[1] respectively, and import prices. If P, C, M represent the three types of prices, and + and − are gains and losses, the gains and losses to the three parties under the two alternative situations of subsidies and no subsidies are as follows:

	With Subsidies	Without Subsidies
Government	− (P-C)	+ (P-C)
Farmers	+ (P-C)	− (P-C)
Consumers	− (C-M)	+ (C-M)
Net change to economy	− (C-M)	+(C-M)

It should be clear that the relevant prices for measuring economic subsidies are the prices to the consumers: the actual consumer prices and the alternative import prices.[2] In this sense, Eberstadt's calculation of subsidies is incorrect because it is based on the procurement price P and the import price M, and P actually is not relevant here: "Korean farmers are being paid about three times as much to grow rice as it

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[1] The consumer price for rice is really slightly above the government selling price. See Edward S. Mason *et al.*, *The Economic and Social Modernization of the Republic of Korea*, Harvard University Press, Cambridge, 1980, p. 235. This, however, does not affect the reasoning here.

[2] One should of course take into consideration the distribution costs incurred in bringing the rice from the port of entry to the consumer. In short, it should be import price (c.i.f.) plus domestic distribution costs.

would cost to buy it abroad."[3] In effect, Eberstadt measures subsidies in terms of $P - M$. Since the procurement price P is higher than the consumer price C, $P - M$ is greater than $C - M$ (M is less than both P and C), i.e., Ebertstadt's measure of $P - M$ is larger than the real subsidy from the standpoint of the economy as a whole.

To obtain a correct measure, data on consumer prices and import prices are needed. Unfortunately, they are not available here. As approximations, an adjusted government procurement price for rice and the unit value of rice imports are used. The procurement price in 1981 was 652,000 won per ton, or $931 per ton at the current foreign exchange rate.[4] Applying the ratio of selling price to procurement price in 1975, 0.86, to the procurement price in 1981, a rough estimate of the consumer price is obtained: 560,720 won per ton, or $800 per ton. The unit value for rice imports in 1981 was $420 per ton.[5] On the assumption that there is a half-year lag between production and consumption, total consumption of domestic rice in 1981 was 6.23 million tons.[6] Economic subsidies in the case of rice production thus totalled

$$6.23 \times (800-420) = \$2.37 \text{ billion}$$

This figure is probably on the high side because the unit value of imports does not include domestic distribution and transportation costs, and because a small portion of rice output is generally wasted, reserved for seed, and other nonconsumption uses. A third and important reason for the upward bias in this estimate is that the official exchange rate may have overvalued the won. The shadow price of foreign exchange may be much higher ian the official exchange rate indicates, so that the import price of rice should really be higher, thus narrowing the gap between consumer price and import price. On the other hand, if we allow for subsidies in barley and chemical fertilizer, total farm subsidies would be larger. Hence, even though the present estimate of $2.4 billion is considerably lower than Eberstadt's estimate of $3 billion, it is still a sizable amount relative to Korea's GNP— about 3 percent when calculated in terms of won.

The problem of farm subsidies is particularly serious because of the tendency for such institutions to be self-perpetuating. To protect their economic interests, the beneficiaries of the system are strongly

[3]Eberstadt, 1983.

[4]For government procurement price, see *Korean Annual 1982*, Yonhap News Agency, Seoul, 1982, p. 142. For the exchange rate, see United Nations, *Statistical Yearbook 1981*, New York, 1982, p. 285.

[5]United Nations, *1982 FAO Trade Yearbook*, Rome, 1983, p. 119.

[6]Outputs in 1980–1981 were 5.311 and 7.149 million tons. United Nations, 1983, p. 111.

motivated to resist changes that might reduce or eliminate the subsidies. Moreover, productivity per unit of input is generally lower because the system supports marginally efficient producers who otherwise would not survive. And producers are under little or no pressure to innovate. Under these circumstances, productivity is likely to fall further behind those in the agricultural exporting countries. If so, the gap enhances the need to protect domestic producers and to pay an increasingly high price to do so.